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AMATEUR REORGANIZATION IN THE NAVY.

In this magazine last month, some aspects of the upheaval in the United States Navy Department were presented to show how disastrously the engineering personnel would be affected. The following article purposes to show the absurdity of other features of the "reform." The conditions affect vitally an important branch of engineering and a National service, paid for by the people, in the efficiency of which they are profoundly interested. As good citizens, engineers should look into the case. Some of the facts are here offered for their consideration.—THE EDITORS.

SCARCELY a day passes without a new order making some change in the scheme for disorganizing the Navy, inaugurated by the Secretary who folded his tent (he couldn't furl sail in a modern navy) and retired to private life on March 4. That changes would be needed in such an ill-digested, unworkable scheme as that first devised was, of course, obvious to anyone who is familiar with executive management, although the surprise at such a scheme has been turned into a different channel by the Secretary's *naïve* statement before the Naval Committees of Congress that he is the sole author of the plan, not having consulted with any naval officer, in or out of the Department. We are strongly reminded of Goldsmith's famous lines:

> And still they gazed, and still the wonder grew
> That one small head could carry all he knew.

There are reasons for believing that the Secretary's statement may have been true in form but not so in fact, as the special shape of his activities seems to harmonize with certain features of his environment. In other words, the particular hue of his "reform" coincides with his favorite associates, just as that of the chameleon does with what it rests on. However, the statement stamps him as a monumental example of egotism or else of incredible fatuity. Men of the greatest ability have hesitated to make changes much less radical

except after conference and advice with experienced counsellors, but here we have his own statement that this complete overturn of a system which was efficient and satisfactory is all his own work, no expert advice having been sought or desired.

The readers of this magazine have seen illustrations of the benefit and necessity of advice from trained men who make organization and systematizing a specialty, and they know that even the most efficient concerns in civil life would hesitate to make important changes, much less radical ones, without securing expert advice; but this naval case affects vitally one of the arms of the national defense, whose maintenance now runs to more than a hundred millions a year, and yet its efficiency is allowed to hinge on the vagaries of a *dilettante* who boasts that changes of an absolutely subversive nature are made on his sole order without consulting anybody who could be considered an expert.

For the benefit of those who are not in close touch with naval affairs, it may be said that the main points of the "reform" are an entire shaking up and changing of the duties of the various bureaus of the Navy Department, with greatly increased power of certain boards, and an absolute change *in name* of the organization of the navy yards. Thus far, the change in the Department at Washington is mainly in the threat of different methods, although no Chief of Steam Engineering has been appointed, the Chief Constructor having been appointed acting chief of that bureau. It is the Secretary's recommendation (and would have been his intention if he could have held on) that the civil engineering bureau (Yards and Docks) be abolished and steam engineering be parcelled out so that its more important work should go to the hull bureau (Construction and Repair) and what is left be made a division in the Bureau of Navigation. The scheme, indeed, has never been carefully worked out, being rather sketchy and hazy. Ordnance apparently is to remain as at present, and doubtless the Secretary, like Warren Hastings, is "amazed at his own moderation." Equipment, which looks after electrical matters is to be wiped out and its work divided. It is presided over by President Roosevelt's brother-in-law, who has passed the retiring age and doubtless holds "after us, the deluge."

For many years there have been, at the Navy Department, two important boards. The General Board is supposed to plan naval campaigns, make suggestions as to types of ships, and keep a watchful eye on the strictly military side of naval affairs. It is a sort of Naval General Staff, but only advisory. Efforts have been made repeatedly to secure for it the same official status as the General

Staff in the Army, but they have failed. The Board on Construction looks after *materiel,* and until recently was composed of the chiefs of the bureaus which have cognizance of *materiel.* Lately there has been no engineering expert on it as a representative of the Bureau of Steam Engineering.

The plans as announced some time ago were to make both of these boards more important by giving them authority over the bureaus, so that, in effect, they would really be responsible, as the bureau chiefs must carry out their ideas. This is the well-known plan of trying to do executive work by committees, which has always proved a failure; as it is bound to do by the very nature of things. Either some one strong man dominates and is really responsible, in which case the scheme is a farce, or else there is constant squabbling and no result except by compromise, which means inefficiency.

At the navy yards, all technical work relating to ships has been put under the hull department, the head of which (naval constructor) is called "Chief Technical Assistant to the Commandant" and also, "Manager of the Manufacturing Department." The civil engineer, formerly in charge of the department of Yards and Docks, is to be some kind of an attaché to the commandant, but only for inspection. The officers formerly managing the departments of ordnance, equipment, and steam engineering, are to be inspectors of the work formerly managed by them. Any one who is familiar with shipyards will see at once how radical this change is, and also that it agrees with no plan ever used in any large manufacturing plant anywhere. This scheme seems devised to secure the maximum amount of friction for a minimum of work done, at a decided increase of cost. Where a customer is having important work done by contract, he has an inspector to be sure that everything is first-class, but nobody ever heard of inspectors of one's own work who are of equal rank and standing with the head man who does the work, and entirely independent of him. The plan seems the product of a confusion of ideas and an attempt to work the inspection feature at the navy yards as if they were managed by contractors. The supreme confidence shown in the corps who are given everything precludes the idea of any lack of confidence by the Secretary in their ability or integrity. Really one is driven here, as in almost every other aspect of the case, to the position of absolute inability to understand why things are done so; ordinary logical processes fail to work with the data supplied.

If the present age is noted for anything it is as an era of engineering and of specialization. This "reform" goes absolutely counter to both. Before the Secretary so modestly stated that he had worked

it all out in his own head, many supposed that the scheme was part of the desire of the line or deck officers for a general staff, and it was a source of great surprise because since 1899 they have been the steam engineers by the Personnel Law of that year. It looked as if they proposed to shirk this part of their work, and leave the care of the machinery afloat to the machinists. However, it is now generally understood that the active line officers do not approve the scheme. It is really hard to understand just what actuated the Secretary; but, trying to be fair with him, it looks as if it were a case of amateur and academic effort at improvement made by a man who thought he saw a chance to link his name with a great change, and whose lack of expert knowledge, and, by his own statement, contempt for or indifference to expert advice, has led him into a very serious mistake. Some of his statements before the Naval Committees show that he appreciates that there must be some specialization, but the idea of centralization is so strong with him as to carry all else before it.

This mania for centralization and consolidation is indicated, on a small scale, in another matter. An order has just been issued abolishing the separate storerooms on board ship and placing everything in a common stock, on the plea that it all belongs to the Navy and should be available for everybody. This sounds well, but it is really absurd. It cannot save a penny in salaries, for the people will still be there who cared for these stores. We also know that the system is faulty, because it was tried twenty years ago and found to be so inefficient that it had to be abandoned. Everything was centralized under Whitney and immense quantities of valuable stores sold for scrap—only to be sold back again a little later. This has been common gossip for years. The claim was made then that efficiency and economy would be increased. The facts are just the reverse. More officers are needed to carry out the centralized plan, and a perfect army of clerks to carry out the greatly increased amount of bookkeeping. All this has been common knowledge. If the Secretary had tried sincerely to find the weak points needing correction, here was one, right at hand. Instead of this, he turns again to this same plan for the ships after it has been tested and has failed.

A feature which always characterizes these amateur attempts at economy is the failure to realize that the cost of excessive accounting is likely to offset far more than any possible saving due to a reduction in the amount of stores carried. In the case of the consolidation of stores on board ship twenty years ago, an elaborate series of regulations was promulgated, designed to cover all possible contingencies. It was provided that the paymaster on each ship should be

the custodian of all stores, and provision was made that the flagship should have a somewhat more elaborate outfit than the other vessels of a squadron. The routine was that the head of a department who needed any stores should make requisition on the paymaster of his own ship through the commanding officer, who would approve it. If the articles were on hand they would then be delivered by the paymaster to the officer making the requisition. If, however, they were not on hand, the paymaster would so certify and the requisition would then be forwarded to the fleet paymaster on the flagship. If the articles were there, they would be sent to the ship making the requisition; but if not, the Commander-in-Chief would then authorize the fleet paymaster to purchase them after a careful effort to see that he got a reasonable price. Where the ship was in foreign waters the paymaster was expected to confer with the consul and get the names of six reputable dealers, if possible, and after asking bids from them, award to the lowest responsible bidder.

This does not look so very bad, although an enormous amount of red tape is involved; but a case once occurred, which is vouched for, showing the absurdities to which red tape can go. About twenty years ago a certain ship was in a foreign port. One of the men was taken sick, and on the recommendation of the surgeon was sent to a hospital on shore. The man finally died, and it became necessary to bury him. The simple and straightforward method would have been to call in an undertaker and have him arrange for a decent casket and a lot in the cemetery. This would be the usual procedure with a business man or ordinary citizen. The *régime* of economy and reform, however, would not permit of so simple a course. What actually occurred was this: The surgeon made a requisition on the paymaster for one coffin. Naturally, he did not have one in stock, and therefore it was forwarded to the fleet paymaster, who also, not being in the undertaking business, had no coffins on hand. Then the Admiral directed the fleet paymaster to purchase one coffin, after obtaining prices from six reputable dealers. The same course had to be followed in securing the grave. The surgeon made requisition on the paymaster for one grave. Strange as it may seem, the paymaster had no graves in stock. Neither had the fleet paymaster. Consequently, the Commander-in-Chief directed the fleet paymaster to procure bids from six reliable dealers in graves, and purchase one from the lowest responsible bidder. All this of course is a screaming farce, but it is the horrible example to show what comes when common sense and experience are set aside to give room for the play of amateur and academic fancy.

If naval organization were along lines totally different from those ruling all other large concerns, or if it had never been tested by the demands of actual warfare, one could understand that there would be some ground for the question whether the existing system was the best. On the contrary, the system which is being overturned is the result of an evolution and a response to the demands upon it; it has been thoroughly tested by two wars, in both of which it was highly efficient; and, in the main, the organization is along exactly the lines found best for efficiency in all other large administrative entities.

To the careful student of the administration of large manufacturing concerns it is most interesting to note how they are forced to copy more and more, as they increase in size, the army model. This is, indeed, only natural, for the army organization has had thousands of years to be tested out with the improvements due to some of the greatest geniuses of the race, and, in general, it ought to be nearly perfect. What do we find? In a small army, one commander can efficiently handle everything. As the size increases we have brigades, divisions, and finally army corps, each of which is a big army. It is just the same with manufacturing. Up to a certain point, a single superintendent or manager can handle efficiently all the details, and the work is generally segregated by operations. As the size increases, however, the complication becomes too great, and the model of the army corps has to be followed. The segregation is no longer by kind of operation, but by the finished product. The plant is laid out as a series of small plants, each complete and self-sustained, for the manufacture of its own product. Duplication of shops, which has been complained of at the navy yards, is here deliberately planned—because experience has shown it to be the most efficient both as to cost and rapidity of manufacture. This is not a secret, but is the recognized practice of the best establishments, and if the Secretary had not deemed himself omniscient, and had adopted the rational method of attacking such a great problem as the reorganization of the Navy, by having a Commission investigate and report, he could have learned all this—and possibly might not have been so keen to change the existing system, which was along these very lines.

A most remarkable feature of the "reform" is that which displaces a lot of officers with special training and long experience, and turns the work over to others who are without these qualities, although the former officers are still in the government service and available. Here again we note the failure to recognize specialization. The world in general (except the Secretary) has long recognized that efficiency in the various branches of engineering can be

obtained only by special devotion to those branches. This efficiency does not come from the book knowledge obtained in the technical schools, otherwise a fairly clever man might qualify in several branches, and the Secretary as a graduate of Sheffield might pose as an authority in engineering. It does come, as all trained engineers know, by the experience resulting from daily contact with the almost infinite details of each special branch. This is why there have always been, until this "reform," the two clearly marked professions of naval architect and marine engineer. They touch at many points, but they are so essentially distinct that efficiency in each requires a different type of thought, because the problems to be solved are entirely different.

At the time of his first appearance before the Naval Committees it was arranged that the Secretary should appear before them again after some weeks to let them know how the new scheme had worked out in practice. He made this second appearance about February 18, and evidently had in mind the remarks which had been made by Senators as to the importance of results, as showing whether the method was good or bad. All through this whole scheme there have been evidences of what, to put it mildly, may be called disingenuousness, and a statement made by the Secretary seems to bear the palm in this line. He stated that the system was working beautifully and in one case, the repairs on the Chester, the new system had brought about a saving of seventeen days. Even to the man on the Street, this must have seemed phenomenal, if he remembered that the system was only put in force on February 1, and it certainly would have been a miraculous kind of work which could save seventeen days out of eighteen. The real facts in the case, as near as anybody not in the Navy Department can learn, are about as follows:

This work on the Chester was started back in December and the estimate of the time needed ran well along until the end of February, if not in March. This was simply a safe estimate, due to depending on certain material to be delivered from outside. Towards the end of January the necessity for expedition became apparent, and inquiry developed the fact that the work could be completed by February 20, provided overtime work was authorized. This was done, and, as will be noted, before the consolidation scheme went into effect. As a result of working overtime the job was finished a little before the middle of the month. In other words if the Secretary's statements were to be taken as correct it would mean that seventeen days were saved in fourteen calendar days of actual elapsed time. He did not state that work had been done overtime, nor did he state that the Chester was

the only ship at the yard at the time, so that all the resources were concentrated on this one vessel. The plain truth is that this had nothing to do with the new system at all. The work was done just as it would have been done at any time, and the work was expedited by working gangs continuously, so that really there was about three times as much work done each day as would have been under the ordinary eight-hour limit when no overtime was authorized. The new system must certainly be in a sorry position if fairy tales like this are needed to help it along.

The last published order, when this was written, showed a disposition on the Secretary's part to provide for emergencies. Even he seems to have realized that the special skill and experience must be provided somehow, and he speaks of the possibility of getting skilled superintendents through the Civil Service Commission. In other words, the skilled *officers* are to be displaced by skilled *civilians*. Now it is evident that no civilians can have the experience which the officers have obtained by sea service and which is of the highest value, and also that the Secretary apparently has no idea of the market value of *equal* skill in civil life. It is actually considerably higher than the salaries paid the officers for the same work. Thus we at last reach the result (which is being provided for) that men of less experience in strictly naval work will be paid more for a given function than the naval officer who is displaced—and all this in the name of economy and "reform."

This article has been confined mainly to a discussion of the disaster to the navy yards, because the change has actually been started there. Fortunately, even this wonderful head that can carry so much, could not, unaided, do everything at the same time, and the Department has not yet felt the withering touch to any great extent. It is one of the greatest marvels of the marvellous administration which closed on March 4, and which stirred up nearly everything that was stirrable, that such complete overturning of a great department should be attempted just at its close. An order taking away most of the work of the Bureau of Equipment was promulgated in the last week in February, to take effect March 1, three days before the end. The service papers which give this news also say, referring to another matter, that the Secretary is highly indignant that Congress should have passed a law counter to his wishes, and he proposed to nullify it as far as possible and simply to obey the letter and not the spirit. This perhaps is the secret. He does not believe in the rule of the people but of the benevolent despot—and he was the despot.

METHODS OF THE SANTA FE. EFFICIENCY IN THE MANUFACTURE OF TRANSPORTATION.

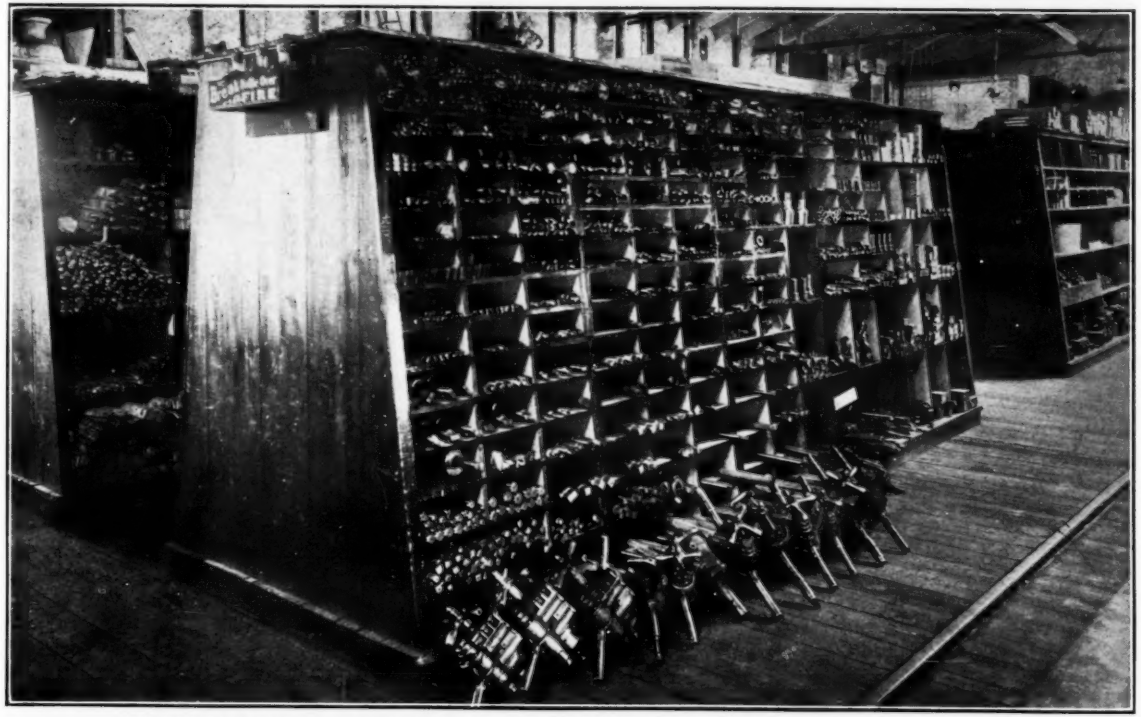
By Charles Buxton Going.

II. THE STORES-KEEPING, SHOP-ORDER AND WORKS-ORDER SYSTEMS.

The preceding article summarized the chief problems of operation on the Santa Fe, and the measures applied to their solution. In this number the stores and manufacturing systems are taken up, as the most central and instructive approach to the advanced policies characterizing the mechanical department of the Santa Fe.—THE EDITORS.

RELATIONS between the Stores and Mechanical departments of the railroad are necessarily intimate. The one is custodian of material and the other of its employment. On the Santa Fe system the relations exhibit phases of peculiar interest. The betterment work of the road includes as an important feature the centralization of all manufacturing at Topeka. It is true that on account of the great extent of the system and the inconvenience of referring important work to too distant a center, a tendency is developing toward the establishment of a second manufacturing organization in the San Bernardino shops—San Bernardino manufacturing for the coast lines and Topeka for the remainder of the system; but at present, with only immaterial exceptions, all new work and all tools and supplies made by the road for its own use are manufactured in Topeka and distributed to the division points and shops. The policy, in brief, is to separate manufacture and repair completely, to apply only finished material to engines or rolling stock under repair, and to direct the issue of that finished material exclusively through the stores department, whether it is bought from outside manufacturers or is made in the shops of the road.

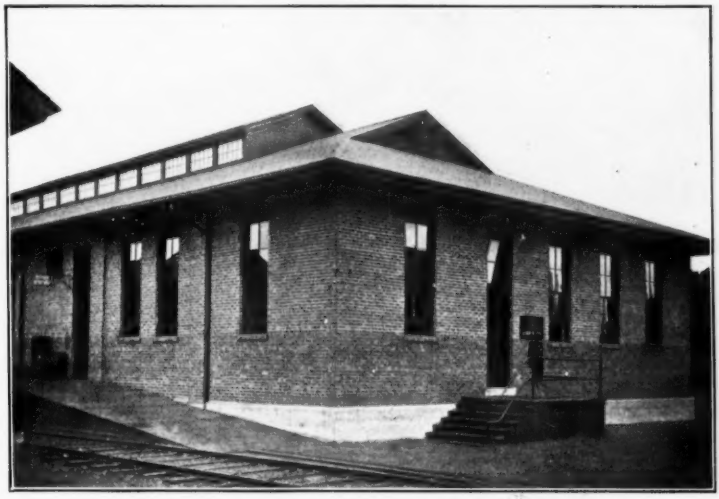
With repairs not requiring material from stores, of course the stores department has no concern; nor has it any function of control over the shops in the manufacture of materials ordered for stores. Each department handles its own internal affairs and adopts its own policies to secure efficiency. At all shops except those in which manufacturing is centralized (that is, substantially all except Topeka and to some extent San Bernardino) the work done is wholly repair. But Topeka is not only a very important repair shop; it is also the manufacturing shop in which the road makes for itself, on its own order,



SURPLUS TOOLS GATHERED FROM OVER-EQUIPMENT AT LOCAL SHOPS AND RETURNED TO CENTRAL STORES.

The reapportionment of work, concentrating all manufacturing operations at Topeka, made it possible to return to general stock many small tools, to be used as needed instead of held in unnecessary or excess local reserve.

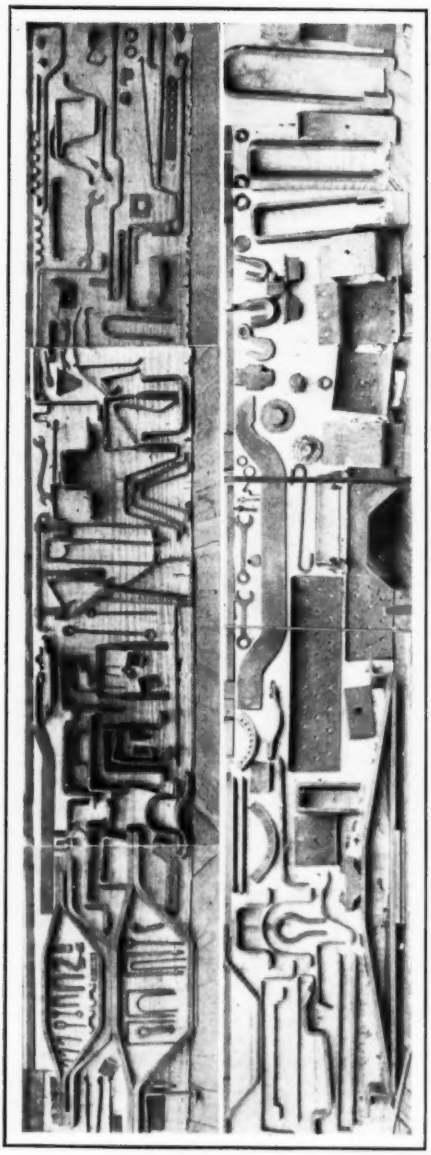
such tools, parts and supplies as it can produce to advantage in preference to buying them from outside manufacturers. So far as these items are concerned, it deals with itself as if it were at the same time an outside manufacturer, the stores department representing the purchasing element in the transaction and the mechanical department the sellers.



OFFICE END OF SANTA FE STORE HOUSE, NEWTON, KAS.
Showing standard type of building.

All shop orders, therefore, originate in the stores department. The shops on receipt of the order make requisition on the storeskeeper for the rough stock, and return the finished material to stores. This holds true not only for standard material, but for special work. It would hold true, for example, in applying new cylinders to an engine under repair at Topeka, although, of course, in many cases of work in progress, delivery to stores and reissue on requisition takes place in the accounts only, and the piece which is thus constructively transferred may be actually taken direct from the machine to the engine on the erecting floor.

The systematic pursuit of this policy, therefore, brings into the custody and into the accounts of the stores department a considerable stock of material and a considerable range of transactions which, under laxer methods, would not reach the view of any official higher than the local mechanical man. Beyond this, the custody of the Santa Fe stores department is extended to cover all the fuel, either coal or

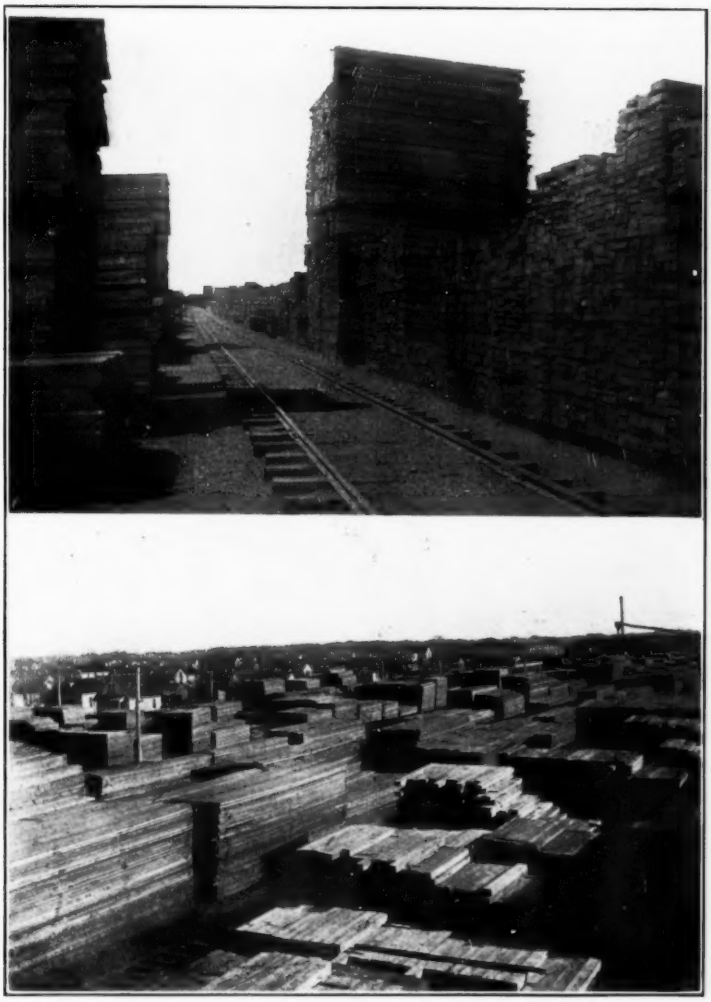


VIEW, IN TWO SECTIONS, OF THE MACHINE-FORGING BOARD AT THE BLACKSMITH SHOP, TOPEKA.

All forgings shown are made, complete, by means of special dies, formers, etc., designed by the blacksmith foreman. The forgings, over 200 in number, are standard and are furnished to all system shops.

oil, used on the system. The stores department of course, is not responsible for the economical or efficient use of material or consumption of fuel; but in the Santa Fe system it is so administered that it becomes an alert, vigorous, and highly energized coadjutor to the operating and mechanical departments in preventing extravagances and in calling attention to inefficiencies so that they may be remedied by the proper officials.

The physical problems of the custody, control, and record of the range of material handled by the stores department covering so large a railroad system and so many of its departments, are necessarily stupendous. There are some thirty division stores and



THE SYSTEMATIC HANDLING OF LUMBER BY THE SANTA FE STORES DEPARTMENT.
Above, bridge and building timber, Arkansas City; below, general stores lumber, Topeka.

sub-stores, and the standard stock carried will comprise 15,000 to 20,000 items at these outlying points and may reach twice that number or even more in the central storehouse at Topeka. The oversight and handling of this multitudinous stock are greatly simplified by a sectional classification according to a standard arrangement. This ar-

PART OF THE INTERIOR OF THE GENERAL STORES AT TOPEKA.

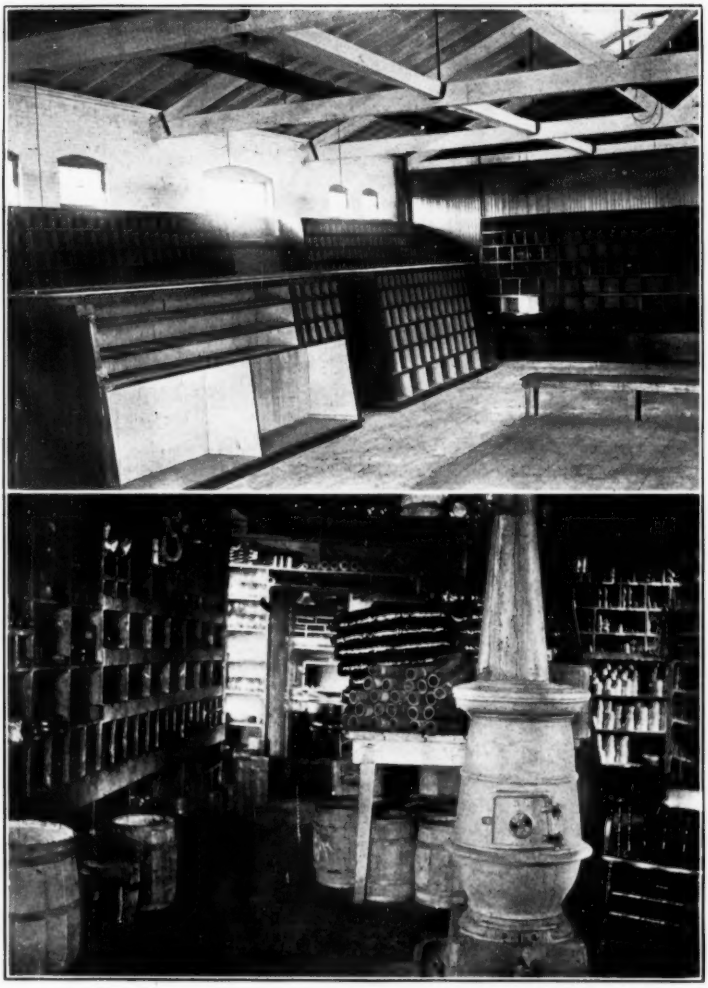
Showing arrangement of racks and shelving for holding materials, and longitudinal disposition of the bins enabling the foreman, from his office at the end, to command a view of the whole floor.

rangement, worked out to its most perfect detail at Topeka, is repeated in reduced scale at all the minor points, and is followed again in the stores account books and in the requisitions filled out by the assistant storeskeeper. This simplifies enormously comparison between the record books and the stock on the floor, between requisitions received at Topeka and the past consumption or probable and reasonable needs of the point making the requisition, and between requisitions received from points where stock is short, and possible stores of over-material at other points where the same items may have become obsolete. The sectional arrangement of material and of accounting therefore is:—

Section.
A. Miscellaneous shelf hardware, car trimmings, etc.
B. Lamps and fittings, packings, tinware, etc.
C. Bolts and nuts, rivets, washers, nails, etc.
D. Pipe and fittings, valves, and miscellaneous water-service supplies.
E. Air-brake material.
F. Miscellaneous brass castings, journal bearings, metal packings, injectors, lubricators, etc.
G. Oils and waste, paints, varnishes, acids, etc.
H. Bar iron and steel, and sheet metals.
I. Wheels and axles, tires, springs, wrought iron forgings, brake beams, flues.
J. Miscellaneous track and B. & B. material.
K. Steel castings, Santa Fe patterns.
L. Malleable castings, Santa Fe patterns.
M. Frames and bolsters, couplers, brake shoes, oil boxes, and misc. castings.
N. Gray-iron castings.
O. Shop tools and abrasive wheels.
P. Dry goods, furniture, belting, hose, rope, glass, etc.
Q. Electrical material.
R. Signal material.
S. Telegraph material.
T. Lumber, Mechanical and B. & B.
U. New steel rail.
V. Old rail.
W. New cross ties.
X. Ice.
Y. Material in process of manufacture.
Z. Miscellaneous scrap.

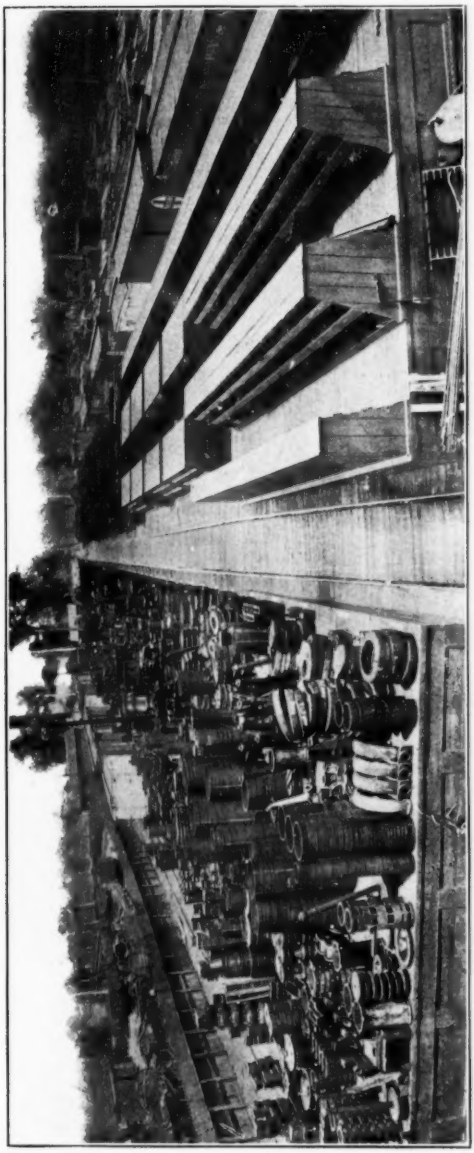
The interior arrangement of the Santa Fe storehouses, and the methods pursued in disposing of the many items so that they are constantly convenient for inspection and for access, are displayed better in the accompanying illustrations than they could be by verbal description. Lighter and more valuable supplies are carried on shelving inside the houses, and heavier stock, such as track material, cylinders, castings, pistons, rods, etc., is systematically arranged on material platforms outside. Locomotive repair parts are classified on these platforms according to engine types, and finished parts subject to injury from rust are painted. Oils, paints, varnishes, etc., are often stored in a separate building.

The record of material is kept in standard stock books, which, as already suggested, reflect the orderly arrangement of the material



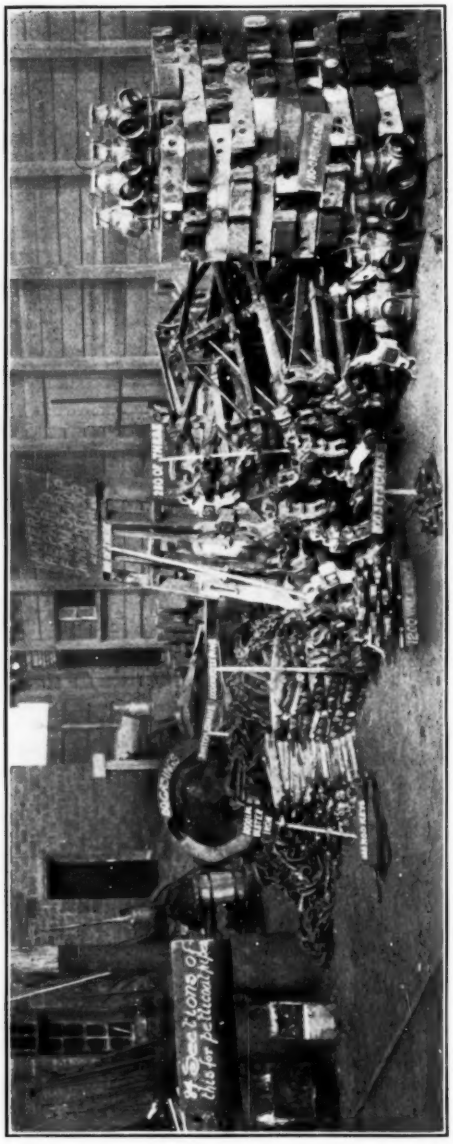
INTERIOR OF OLD STOKE HOUSE, CHANUTE, KANSAS, AND OF THE NEW. A CONTRAST OF METHODS AND RESULTS.

and its location on the shelves or platforms. Two columns are provided, showing the inventory of material on hand and the quantity to be ordered each month. Space is also provided for showing the total issues for the year and the actual quantity of materials and supplies on hand at the close of the fiscal year, or exhibited by the physical inventory. At the close of each month a requisition for material



CASTINGS PLATFORM FOR FINISHED MATERIAL, TOPEKA GENERAL STORES.
Showing the orderly, classified arrangement of heavy castings, etc.

required is made on standard forms and the stock books and requisitions are sent to the general stores, where the local requisitions are revised, the orders are placed for such material as is allowed, and the books are returned to the local storeskeeper, only one set of books being used. It is at this point that careful examination is made to prevent overstocking of division or sub-stores, and to recall material which is in excess of possible requirements, or which perhaps is no longer alive on the division where it is stored, so that it may be transferred to points where it can be used. Very careful oversight is exercised to prevent the scrap-



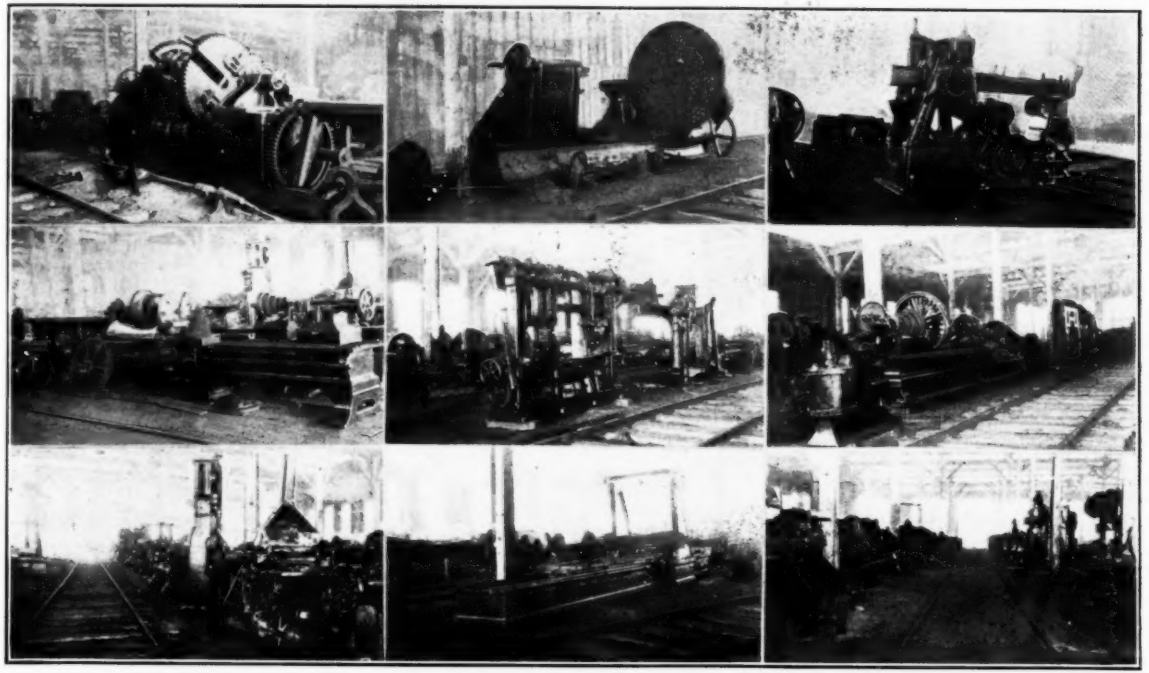
MATERIALS GATHERED FROM SCRAP AND PUT INTO SERVICEABLE CONDITION, ALBUQUERQUE SHOPS.

The catalogue of items in this one collection includes 84 sections petticoat piping, 50 cylinder-head castings, 50 lb. ulster iron, 1,000 knuckle pins, 1,200 wrenches, 250 brake beams, 800 set screws, 150 drawbar yokes, lanterns, switch-chains, etc.

ping of serviceable material, and at all division points where stocks of such material are likely to accumulate, cheap but competent labor is employed to sort over and restore to usable condition bolts, keys, rods, brake beams, and a long list of miscellaneous parts which, after repair, are returned to stock and save to that extent the purchase of new material. And even after the local shop officials have gone over the material, it is carefully inspected again when it has been assembled at a central point for final sorting into the various grades of scrap, thus introducing an additional safeguard against the chances of good material being thrown away.

PRACTICAL METHODS FOR AVOIDING SCRAPPING OF USEFUL MATERIAL.
Mexican laborers straightening brake beams on a bulldozer behind the San Bernardino blacksmith shop. "Queen," who holds the beam in position, has been six years in the service. He handles all work on this machine and on the Ajax power bulldozer; wages, 22½ cents an hour, and helper's 12½ cents an hour.

When the material in question is stuff bought on guarantee (as for example brake beams, car wheels, steel bolsters, etc.) which has failed short of the guaranteed service, it is jointly inspected by a representative of the mechanical department and a representative of the manufacturer. Everything returned to service passes again to the custody of the stores department, but is credited to the operating department, and the total of the figures is important. In scrap brass alone the amount recovered and sold amounted to $696,159.01 in 1907 and to $342,520.21 in 1908. The value of new brass purchased in these years was $1,292,184.93 and $421,284.95 respectively. The scrap delivered therefore amounted to 54 per cent of the new brass purchased in the former year, and to 81 per cent in the latter. The figures reflect also interestingly the high prices and active business of 1907, and the low prices and slack business of 1908. The material returned to stock, including serviceable material taken from scrap, machinery gathered from the road, etc., amounted to 6.5 per cent of the purchase of new material in 1907, and to 6.7 per cent in 1908.



LARGER RESULTS OF THE CONCENTRATION OF MANUFACTURE OF FINISHED PARTS AT CENTRAL SHOPS.

Typical machines representative of the tools which have been and are being brought from outside shop points where they are no longer necessary, to Topeka. They thus become available for extensions of main shops or equipment of new points.

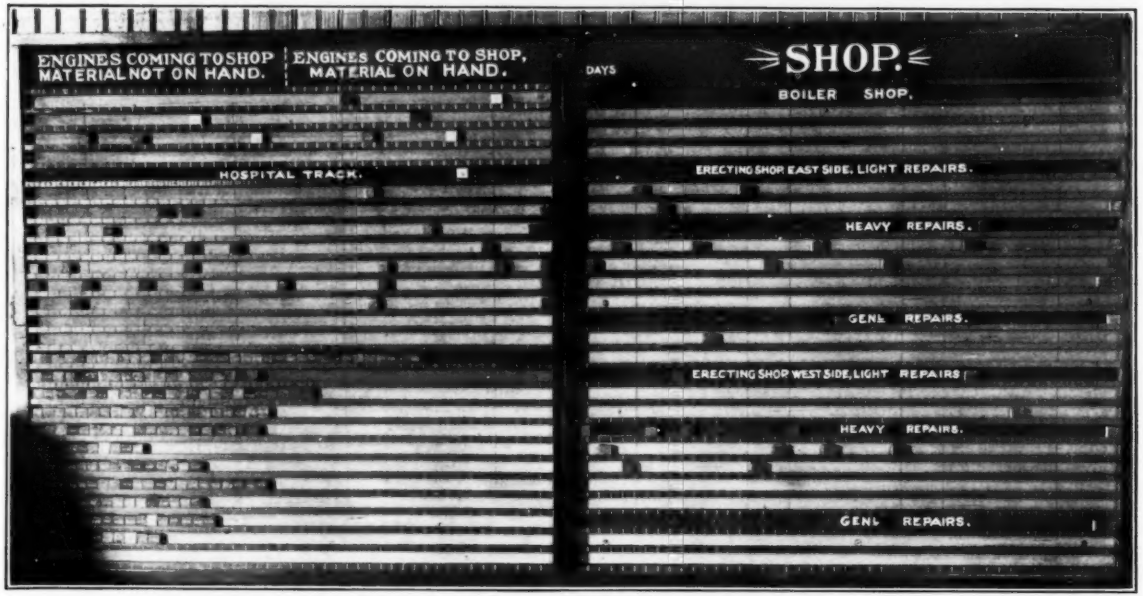
To avoid the delay and inconvenience of detail requisitions upon the local stores for every item needed in miscellaneous running repairs, as, for example, on the "rip" track, a "working stock" of materials in most frequent use is kept convenient to those parts of the shops and is accounted for by general requisitions for a month or other convenient period.

The tool account of the separate shops is submitted monthly in separate record books to the office of the superintendent of motive power, showing the numbers of each tool on hand, and the quantities ordered. These tool requisitions are considered, and if necessary modified, by the mechanical department, and sent to the stores department only after the conclusion of this study has been reached. Requisitions for new tools are not issued unless tool-breakage clearances for the broken and worn-out tools are shown, the same rule being thus imposed upon the shops which each shop in turn imposes upon the individual workman. This, indeed, is but another manifestation of the vigorous care with which the mechanical department supervises all maintenance expenditures. A checking up of the complete inventories of all shops and roundhouses is regularly conducted, with a view not only of minimizing monthly requisitions but of returning to general stock any tools accumulated in excess of local requirements and reserve. Further yet, the concentration of the manufacture of finished parts at central shops, already spoken of, has made much of the machine equipment at division points and smaller shops unnecessary, and not only small tools but machines in large number are constantly brought back into general stock and held for renewals, for equipping extensions of main shops, or for the shops of new lines. The results of the consistent application of this policy in connection with the other and larger features of the efficiency effort, as evidenced in the cost of repairs and renewals to shop machinery and tools, are shown in the figures below:—

REPAIRS AND RENEWALS TO SHOP MACHINERY AND TOOLS.

Fiscal Years.	Total Charges.	Cost per Locomotive.	Cost per Tractive Unit.
1902-3.....	$401,809	$306.96	$ .0136
1903-4.....	487,170	339.96	.0132
1904-5.....	486,620	334.68	.0127
1905-6.....	367,474	225.03	.0081
1906-7.....	315,844	176.35	.0060
1907-8.....	290,809	157.11	.0053

The shops of the Belen cut-off were thus fully provided without additional capital investment. Even the motive power is similarly scrutinized; and recently, with the approval of the operating department, two-hundred locomotives were tentatively withdrawn from service,



BOARD FOR RECORD OF ENGINE-REPAIR MATERIAL AND REPAIRS, GENERAL STORE-KEEPER'S OFFICE, TOPEKA.

The blocks are numbered to correspond with the engines. Their color shows whether the repair material is on hand, incomplete, or lacking. Their position on the board shows the date when the engine is scheduled to reach Topeka, when it arrives on the hospital track, or when it is placed in the shops. Yellow (which shows dark in the photograph) is the color indicating repair material all ready. Note that while material is completely ready for some engines not yet arrived (as shown in upper left section of the board) not a single engine on hospital track or in the shops lacks any repair material.

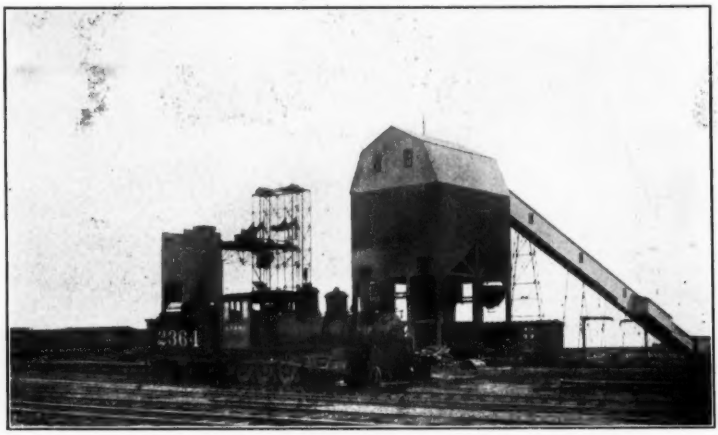
with the sole purpose of increasing the efficiency in the use of the remainder. But this is getting quite beyond the province of the stores department, to which we will return.

MATERIAL PLATFORM, NEWTON, KANSAS.
Showing repetition, at a local point, of the methods and system established in the general stores at Topeka.

Requisitions for standard material are made by the storeskeepers but once a month, immediately after the monthly inventory is taken. Requisitions for special materials, however, are made as necessity demands. Storeskeepers are required to consult frequently with heads of departments concerning changes in standards, or work coming into the shops, so that on the one hand they may avoid overstocking with material on which standards may be changed, and on the other hand they may be supplied in advance with all necessary stock so that delays to construction or repairs may be absolutely avoided. The precision with which this latter result is secured is indicated in the accompanying illustration showing the board on which record is kept of engines coming into the Topeka shops for repairs. This, it is true, is the central point where facilities are the largest, but it is also enormously the heaviest in its demands upon the stores department, because, as already noted, all the manufacturing, overhauling, and reconstruction of motive power and equipment is carried on here.

The monthly requisitions for standard stock are sectionalized—that is, a separate requisition is made for material from each of the

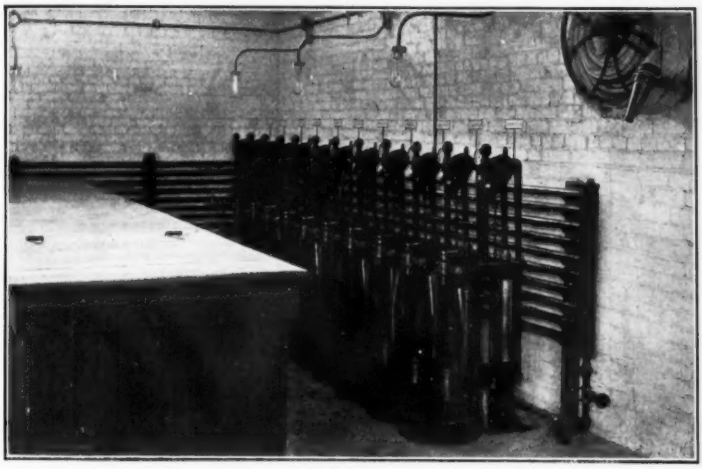
sections already defined. Upon receipt in the central storehouse, the sectional requisitions are given to the men in charge of the respective sections, who then fill the orders from the sections under their charge and bring them out to the loading platform, where the various lots are reassembled according to destination so as to complete the full requisition for each division storehouse. This method of handling simplifies the work and avoids all confusion of cross travel and miscellaneous trucking, so that the shipment of even thirty or forty carloads a day creates no disturbance whatever—in fact, the storehouse looks almost idle. A notable feature of the arrangement is the disposition of the shelving along long aisles, which are completely commanded by the view of the storehouse foreman. (See page 14.)



COAL ELEVATOR AND CHUTES, CLOVIS, N. M.
Adjuncts to the fuel-supervision system of the Santa Fe.

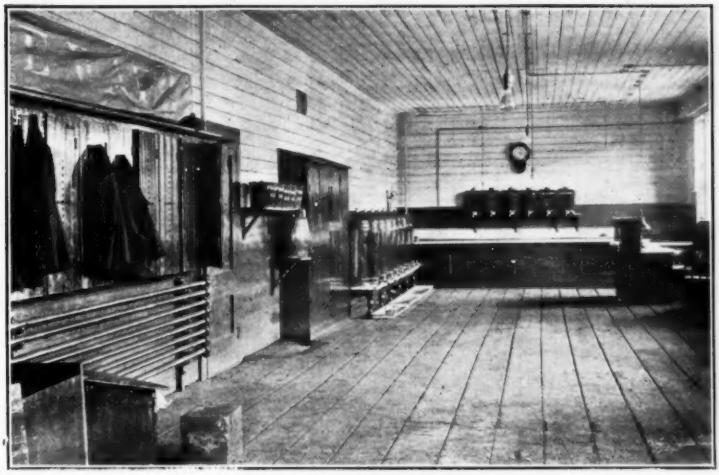
The control of fuel covers both receipt and issue. The former is notable chiefly for the provisions to prevent loss and waste, and for the peculiar problems arising in the accurate accounting for fuel-oil stores because of the character of the material.

The issue is remarkable for a system which extends to the compilation of daily reports showing the amount used each day on each run of every locomotive on the system. These reports are based upon tickets made out by the fuel foreman for every quantity issued; the form is filled out in triplicate, one copy being given to the engine man, and another sent to the fuel supervisor. The miles run by the locomotive are taken from the train sheet, and the statement ultimately reaches stores headquarters with all records reduced to a unit basis of pounds of coal or oil burned per 1,000 ton-miles hauled for



OIL DEPARTMENT IN NEW STORE HOUSE, CHANUTE, KANSAS.
The oil is stored in tanks below ground, and delivered in automatically measured quantity by compressed air. Any drip or spill is returned to storage through the pans under the spigots.

each engine and crew. The records of the several engineers making each regular run are averaged, this average being taken as a standard, and returns are made to the operating officials so that cases of excessive fuel consumption can be investigated, and if expedient the



INTERIOR OF PAINT SHOP, ALBUQUERQUE. A MODEL OF NEATNESS, AND AN EXAMPLE OF SANTA FE IDEALS.

Form 814 Standard

Santa Fe

Western Division A. T. & S. F. (Insert name of Railway)

Daily train tally sheet and train dispatcher's report of train tonnage and fuel consumption per 100 tons miles in Freight Service. Date Feb. 19th, 1908 19

Train No.	Kind Train	Conductor	Engineer (Initials and name in full)	Fireman (Leave blank)	Engine No.	From	To	Actual Train Miles	Total Time in Service Hrs.	Min.	No. of Stops	Tonnage Leaving 790	754	3551	670			Not to be filled in by Train Dispatcher Ton Miles	Coal or Oil Consumed	Average Tons per Train	Average Pounds of Coal or Oil per 100 Ton Miles	Remarks If Light Engine show reason for running etc.
34																						
1/34	R.R.	Thomas	F. Brandt	O. Singley	1481	780	839	166	10	25	10	1623	1623	1623	1623			269418	@ 0.0.0	1623	10.39	
2/34	R.R.	Young	F. Gibbs	J. M. Shaw	1353	"	"	166	8	30	7	1262	1262	1262	1277			223372	2 0 0 0	1345	12.53	
3/34	R.R.	McLaughlin	J. J. LeHeyn	F. Bell	1870	"	"	166	8	45	9	1274	1274	1274	1300			209116	1 8 0 0	1260	8.61	
EX	Drag	Robinson	F. Ramsden	C. Campbell	1865	"	"	166	14	15	7	1902	1900	1900	1530			306512	2 6 0 0	1846	8.48	
EX	"	Burton	S. Cummings	H. Hinkle	1855	"	"	166	13	00	8	2035	2200	1850	1375			329250	3 0 0 0	2025	11.80	

The Engineering Magazine

FORM 814. HEADING AND RULING OF DAILY TALLY SHEET OF FUEL USED AND GENERAL CONDITIONS. THE KEY TO FUEL ECONOMY. The original is 17½ by 16½ in. To bring it into page compass, three columns are omitted—"Time Called," "Time of Departure," "Time of Arrival." At the bottom of the sheet are general instructions and a space for note of weather conditions. The entries are made daily by train dispatcher directly from train sheet. The report is made **in triplicate, original going to superintendent,** duplicate to master mechanic, and triplicate remaining in stores department for use in making the monthly report Form 1133.

attention of engineers can be called to their extravagance. The system is diligently followed up, and if an engineer reported as wasteful continues to show bad results, further inquiry is made as to what has been done in the case. Very interesting conditions are disclosed by these returns—as, for example, that a certain engineer may use his fuel very efficiently on uphill work, as compared with other engineers making the same run, and yet appear the most extravagant drifting back over the same run. The daily fuel records then make an eloquent appeal for the road foreman of engines to show that engineer how to handle his fire when drifting. The 814 report is shown

Form 1133 Standard

Santa Fe

(Insert name of Railway Company)

Fuel Performance of Engines, Engineers or Firemen.

Division Month of 19

	Total Engine Miles	Total Ton Miles	Pounds of Coal or Oil Consumed	Average Pounds of Coal or Oil per 100 Ton Miles	Average Tons Hauled per Train	Total Money Loss or Gain due to Performance shown, Based upon Average Cost per Ton Mile	
						Loss	Gain

The Engineering Magazine

FORM 1133. FUEL PERFORMANCE OF ENGINES, ENGINEERS OR FIREMEN.

Original is 11 by 17 in.; made out monthly from the 814 report, on tracing paper for multiplication by blue-printing; posted at all round houses so that engine men can see their performance. The left-hand space (not shown) is for individual names. When these reports are sent out, the stores department calls attention of superintendents and master mechanics to engine men whose performance can be improved. Continual exhibition of these figures to mechanical and operating officials, dispatchers and engine men, is expected to reduce the differences in economy and raise the general level of performance.

herewith. It is returned daily to superintendents and master mechanics with a letter calling attention to excessive consumption of fuel. If the weather was good and trains moving on time, the master mechanic calls on the engineer for explanations; if the engineer has been delayed after he was called, or on the road, the explanation is sought from the dispatcher by the superintendent.

The fuel was turned over to the stores department for two lines of the system in the autumn of 1907, and for the Atchison proper on June 1, 1908. The fiscal half-year ended last December showed a decrease in fuel consumption, on the ton-mile basis, of 6.4 per cent, and in value of fuel consumed of 16 per cent.

It has already been noted that the stores department originates orders for supplies to be manufactured in the shops of the road, just as if the shop were an ordinary commercial establishment wholly independent of the railway. Furthermore, the shops manufacture nothing except upon order of the stores department. The handling of the "Stock C shop orders" covering the manufacture of material, after they are received, rests wholly with the mechanical department; but if work should be slack and the superintendent of shops desires to keep his plant busy on standard material, he can do so only after the issue of shop orders by the general storeskeeper.

Form 1065 Special

Santa Fe

STORE DEPARTMENT.

S. O. _____ 190____

Reqn. _____

Store No. _____

TO MECHANICAL DEPARTMENT: please _____

and charge to account _____

Forward material to storekeeper when completed

REQN. NO.		AMOUNT	

Form 1065 Special

Santa Fe

STORE DEPARTMENT.

S. O. _____ 190____

Reqn. _____

Store No. _____

TO GENERAL STOREKEEPER:

Herewith please find the following

NOTE-This is to be delivered with the material

Form 1065 Special

Santa Fe

STORE DEPARTMENT.

S. O. _____ 190____

Reqn. _____

Store No. _____

TO MECHANICAL DEPARTMENT: please _____

and charge to account STOCK C _____

Forward material to storekeeper when completed

Labor, month of _____ $_____

Mechanical Department will make requisitions on Store Department for material to fill this order, giving the charge and number of this order on each.

Reqn. _____

STOCK C

STOREKEEPER:

Herewith please find _____

Signed _____

Labor $ _____

NOTE-This is to be delivered with the material

The Engineering Magazine

FORM 1065. SHOP ORDER. ISSUED BY STORES DEPARTMENT TO MECHANICAL DEPARTMENT FOR MATERIAL TO BE MANUFACTURED IN THE SHOPS.

The original is 12½ by 8½ in. in size. The central section "To General Storekeeper" is really printed on the back of the form, so that the sheet may be folded under and all three parts filled at one writing with carbon transfers. It is reversed here for convenience of display. The use of this form is explained on page 29.

Permanent shop-order numbers have been assigned for the manufacturing, finishing, or repairing of all material ordinarily used, a list being arranged in alphabetical and numerical order, with a series of numbers for each class of material and blank numbers for additional articles that may be required. Shop orders are made by the stores department in triplicate on the form shown on page 28, the

Form 1071 Standard

M.D No. 41100 Santa Fe

S.O. No. _____

Store Keeper _____ 190____

Please deliver to bearer

Charge Acc't _____

Foreman

The Engineering Magazine

S. O. No. .....

Topeka, Kansas .....190.....

.....

Foreman of the Material Gang

Please deliver to Foreman .....at machine No. .....

the following material:

.....

.....

.....

Delivered .....

Signed: ....., Foreman

The Engineering Magazine

FORM 1071 AND DELIVERY SLIP. USED BY THE SHOPS TO OBTAIN MATERIAL FROM STORES.

Form 1071 is 6⅛ by 4⅛ in. and delivery slip 8 by 4 in. The mode of use is explained on page 30.

original and one carbon copy being forwarded to the mechanical department, and the other carbon being retained. The carbon copy furnished to the mechanical department is returned to the stores when the material called for by the shop order (or the last installment of the material) is delivered to the stores department.

(Form 2012 Standard)

Santa Fe

11-21 1908

STOREKEEPER:

The following material on your Order No. 12413 is finished and ready for shipment:

NUMBER	DESCRIPTION OF ARTICLE
1	Coach step
	K. R. Stewart
	La Junta

The above material inspected and checked by me and found to be in accordance with specifications and drawings.

John Hartley Foreman

190—

The above material received by me in good condition this date.

H. E. Ray Storekeeper.

190— H C K 11/24

The Engineering Magazine

FORM 2012. SHIPPING FORM.
Original is 5¼ by 8¼ in. Used to notify stores department of completion of work ordered on 1065 forms. See below.

The superintendent of shops, upon receipt of the shop order, directs it to the department in which the work is to be done. Requisition is then made upon the stores department for any material needed, using for this purpose the form shown on page 29 and sending it to the foreman of the material gang with a delivery slip attached for presentation at the storehouse. The storehouse foreman fills the requisition, retains the 1071 form for his departmental records, and returns the delivery slip with the material by the trucker, having first affixed his O. K. as assurance that the material is on hand. The foreman of the material gang then sends the material with this delivery slip to the workman at the machine designated; here the slip is again O. K.'d to show final delivery to the job, and then is returned to the shop-order foreman. On all engine work the 1071 form is made out in duplicate, one copy going as before to the storehouse and one to the office of the superintendent of shops.

When any material made on shop orders is finished, a shipping form (2012) is made out in triplicate by the foreman completing the order; one carbon copy is retained in the mechanical department, the original and the other carbon going to the stores department with the material delivered. The stores department retains one of these two copies and returns the other to the mechanical department as evidence of the delivery of the material. This form is made out for all completed orders, even if the material is not delivered into stores at all but is applied at once, or, as it is called, "issued at the shops."

Form 1256 Standard

Santa Fe

The Atchison, Topeka & Santa Fe R'y Co.

FOREMAN'S ADVICE OF WORK COMPLETED

Shop Clerk: Oct 13 1908

All work chargeable to S.O.No. 9201 has been completed and delivered to Stock 8/18

The following orders issued on Store Department for material:

158538

158151

Cross order made on

Material used from stock on back of this

W. L JURY
Foreman

The Engineering Magazine

Material used from Mechanical Dept. Stock		
	TOTAL	
	KIND	
	Pieces lb. or Ft.	

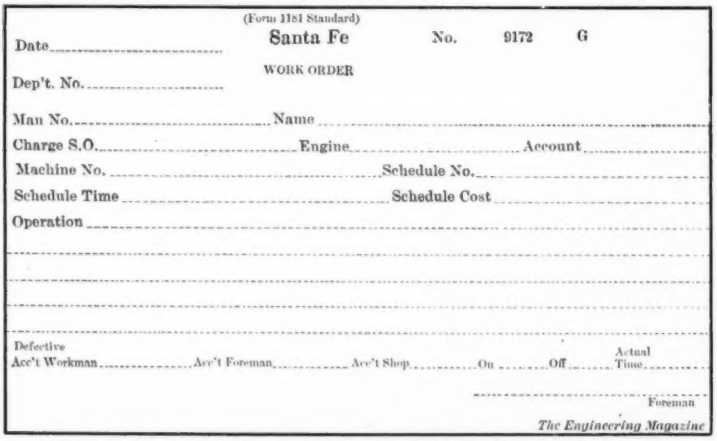
The Engineering Magazine

FORM 1256. NOTIFICATION OF COMPLETION OF WORK DONE ON SHOP ORDERS. Original is a card 5½ by 3¼ in. The lower figure shows the ruling of the back for entry of materials used. The use of the form is explained below.

Finally, a completion card (form 1256) is issued by the shop foreman upon the completion of every shop-order job. It shows on the face the number of the order finished, and on the back the numbers of all requisitions for material drawn on account of the order. This goes to the shop clerk and is forwarded by the mechanical department to the stores department.

For handling the work in the Topeka shops, the mechanical de-

partment has developed a most interesting application of the centralizing principle, individual enough to invite careful attention and study, and suggestive of large possibilities of use elsewhere. The conditions are highly complex, work on shop orders for stores, for immediate application, for outside points, and repair work of all kinds and of all degrees of urgency being in hand at the same time. On an average, about 60 per cent of the whole activity of the shop is given to manufacturing and about 40 per cent to repairs.


(Form 1181 Standard)

Santa Fe No. 9172 G

Date.....

WORK ORDER

Dep't. No.....

Man No..... Name.....

Charge S.O..... Engine..... Account.....

Machine No..... Schedule No.....

Schedule Time..... Schedule Cost.....

Operation.....

Defective Acc't Workman..... Acc't Foreman..... Acc't Shop..... On..... Off..... Actual Time.....

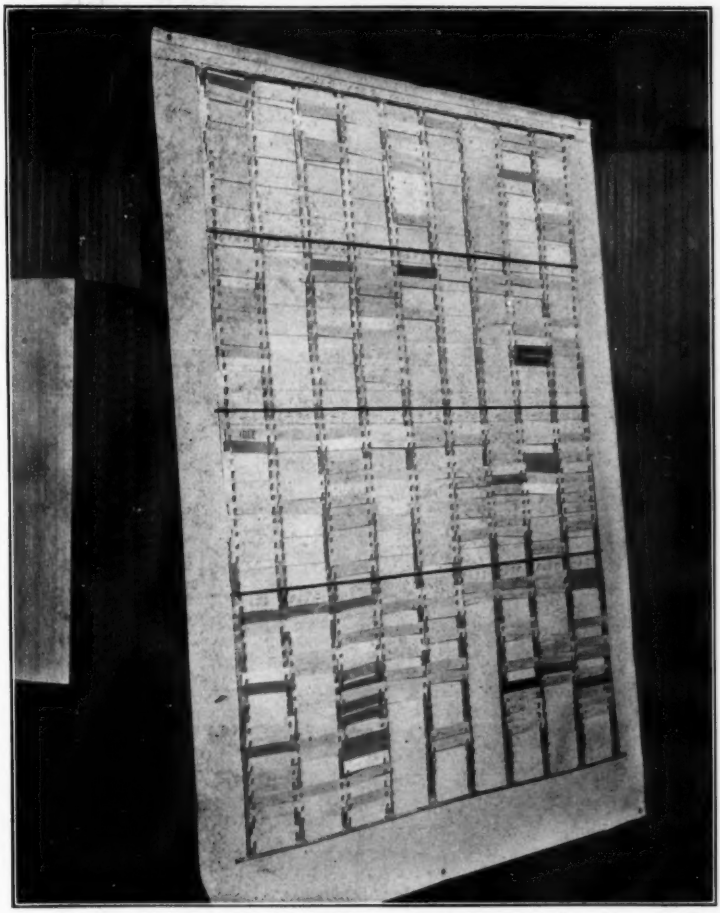
Foreman

The Engineering Magazine

WORK ORDER. ISSUED BY GENERAL MACHINE FOREMAN, TOPEKA SHOPS.
Original is a slip 5 by 3 in. in size.

The handling of all work is centralized under the general machine foreman with the aid of a dispatching system and a record board, by which the work under way or the work accumulated at every machine in the shops is immediately under the eye of the official responsible for progress. The urgency of each job is determined by its character—whether it is for stock, for repairs to shop machinery, for engines under repair by the established time schedule (to which reference will be made later), or for rush jobs.

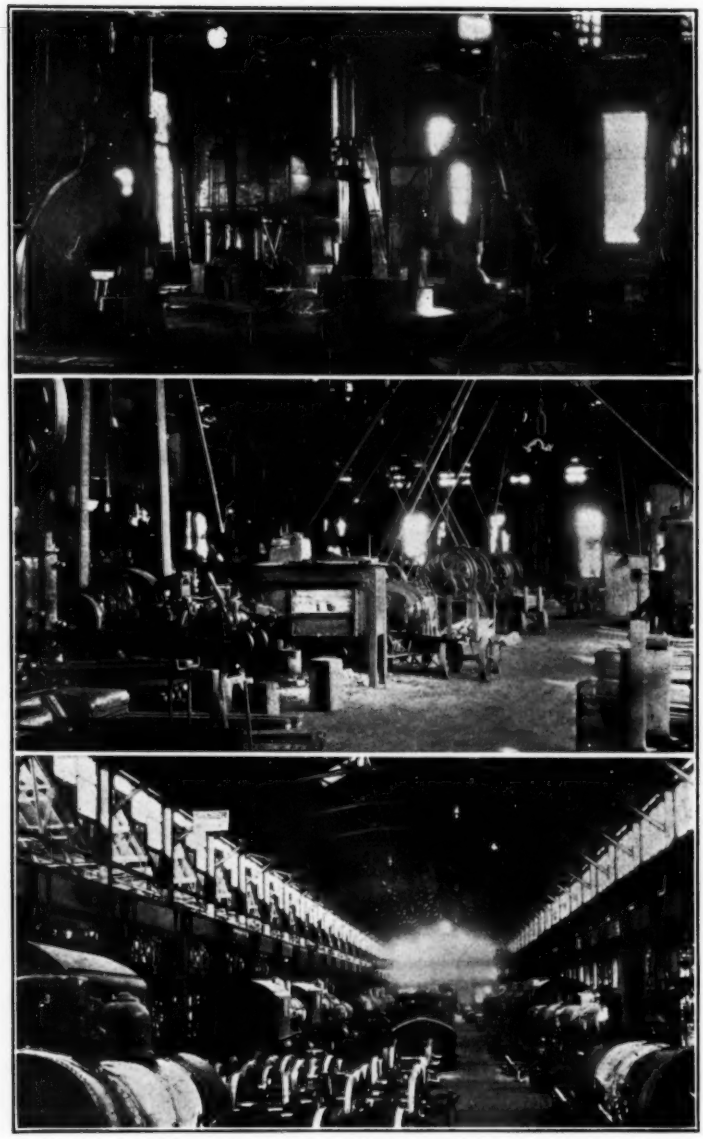
The machine foreman has before him a large record board, divided into three parts corresponding to the three great divisions of the shop, each part being sub-divided into a large number of rectangles representing the individual machines, and distinguished by the individual machine numbers. This ruling and numbering is done on a large sheet of manila paper covering the whole face of the board, over which is placed an open metal framework of narrow strips corresponding to the rectangular rulings of the board. When a work order has been assigned to the machine where it can be done in best



MACHINE-SHOP DISPATCH BOARD, GENERAL MACHINE FOREMAN'S OFFICE, TOPEKA SHOPS.

One section, showing the manila paper backing, tin rack, and arrangement of work-order slips under machine numbers as explained on page 32. There are three sections, corresponding to three divisions of the shop floor.

accord with the requirements of its own special case and of other work in hand, a work-order slip is made out on the form shown opposite and sent out to the workman on the machine to which the job is assigned. A brief description of the work order is immediately written on a small paper tag, the color of the tag used indicating the character of the job. A white tag is used for work on engine parts



IN THE TOPEKA SHOPS—THE CENTRAL MANUFACTURING PLANT OF THE SANTA FE.

At the top, a corner of the blacksmith shop, showing heavy hammers and oil furnace in background; next the power machines in blacksmith shop for making the forgings shown on page 12; at the bottom, the main or center bay of the machine shop; heavy machines are in the bay on the right of this, and light machines in the bay on the left.

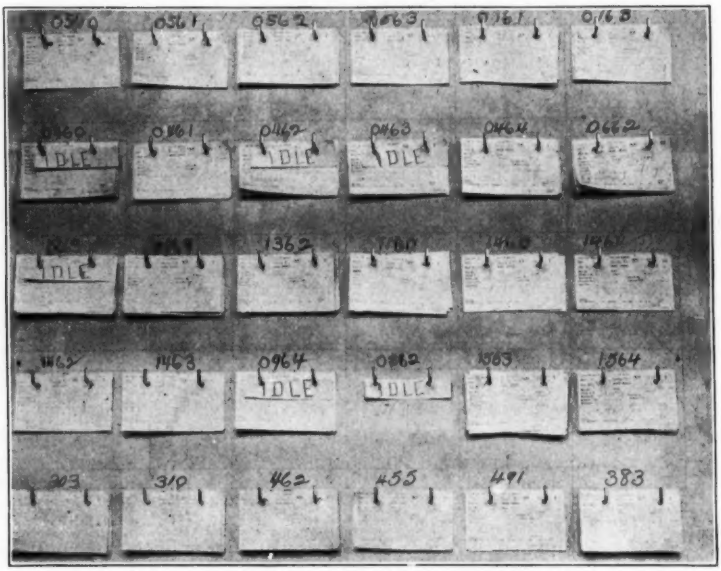
which are to be repaired, machined, etc., and put back. Blue tags indicate new work for engines; pink tags, repairs to shop machinery, etc.; green tags, shop orders for material for the storehouse or the road; and red tags are used for rush work. The tags corresponding to the work orders assigned to each machine are slipped into the space on the record board corresponding to that machine and designated by the machine number. Telephone connection from this board to various parts of the shop keeps the foreman constantly informed as to movement or progress of work without the need of personal visitation.

The job on which work is being done is always represented by the uppermost slip, while any others filed below show the work ahead of that particular machine. When a job is finished, the work order is returned, the tag representing it is removed from the record board, and the time shown on the work order is copied on the manila paper underneath. On Saturday night the metal frame, still holding all its tags representing unfinished work, is lifted off; the manila paper sheet which now holds the time records of all jobs finished during the week is removed, is cut into sections corresponding to the machines, and these sections are filed away under the individual machine numbers. A new sheet ruled and numbered in the same way, but otherwise clean, is attached to the board and the metal frame holding the slips for all work still unfinished is replaced.

The work orders after a job has been finished and its time entered on the record board go to the bonus clerk.

Work orders are made in triplicate. One copy is sent immediately to the bonus department when the job is given out. One, as just mentioned, goes to the workman to be returned when the work is finished, and then goes to the bonus department with all time entries completed. One remains with the machine foreman for permanent record and is filed according to the job number. Two complete files, therefore, remain in the office of the machine foreman, one by consecutive job numbers, one by consecutive times on every machine. It is thus possible to refer back for any information desired, or to fix responsibility for any work done, without the least difficulty or delay even after the lapse of many months.

An improvement in details of this system had been under experiment for some time when these studies were made, with very successful results. Under this new system, instead of writing out separate tags, the triplicate of the work order is used. It is punched with two holes and placed on hooks under the machine number on the board, the order for the job the man is working on being placed on top if



SECTION OF NEW FORM OF WORK-DISPATCHING BOARD.

The work orders for jobs assigned to the machines are hung on hooks under the number corresponding to the machine on which the job is to be done.

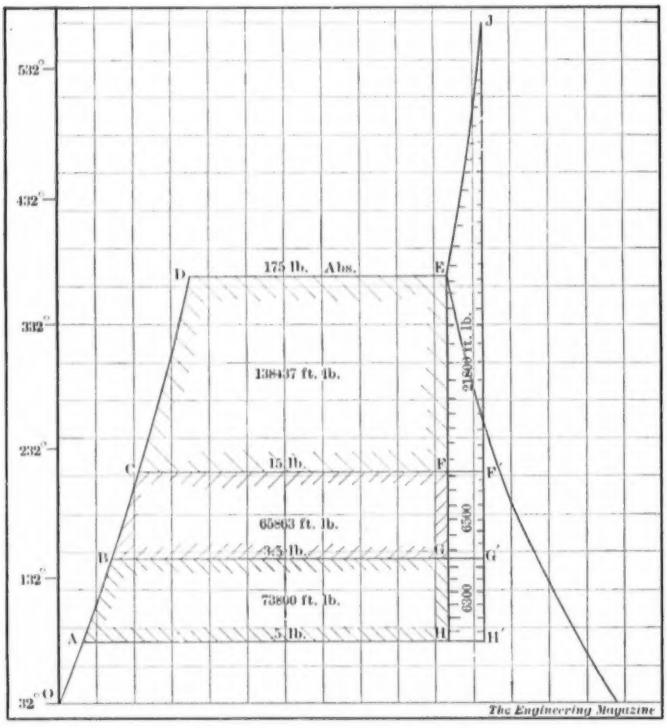
several orders are assigned ahead to any one machine. When the job is completed, and the orignal works order is returned to the office, the operator takes the triplicate off the board and copies upon it the starting and finishing times and the time consumed, and then files the triplicate consecutively under the machine number. This system is believed to show advantages, as it avoids the labor of making out the slips and of copying the time records and other data onto the sheet, and it avoids the annoyances occasionally experienced under the old system from the loss of a tag on account of the tin rack becoming flimsy or out of shape and letting the tag drop. It also makes it easier for the general foreman to refer to past records, if he has a job for which there is no schedule, and thus to obtain data upon which to gauge the estimated time; for it is to be noted that under the Santa Fe efficiency system every job is scheduled, and if no schedule exists a careful estimate is made and is final for bonus calculations, at least until the work is restudied. We are thus brought to the operation of the efficiency system, which is so vitally important in the Santa Fe policy for economy of maintenance, and which will form the subject of the next article in this series.

THE FIELD AND FUTURE OF THE LOW-PRESSURE STEAM TURBINE.

By Ira N. Hollis.

This discussion by Professor Hollis of the fundamental theory and fields of usefulness of the low-pressure turbine, will be followed next month by a review of its history and a study of examples in service, and the series will conclude in June with an examination of marine applications.—The Editors.

THERE has never been a more interesting period in the development of machinery for the production of power than the present. The steam engine is slowly giving way to the steam turbine and the gas engine, except for certain purposes to which it is specially adapted. Perhaps it would be more accurate to say that each of the three types is finding its special field. Nevertheless, the steam engine for large power stations is in danger of becoming antiquated within a few years unless some method for improving its efficiency can be discovered. The steam turbine is already giving better results for new installations, and the gas engine needs only the ability to take care of overloads and large fluctuations of the load to reach the front rank for most purposes. The question is becoming common: "Does it pay to run large steam engines for central power stations even now?" Fortunately for the steam engine, the answer can be given with greater confidence since the production of a low-pressure turbine has made it possible to rejuvenate the most antiquated and wasteful plants by bringing their efficiency up to that of good steam turbines. The low-pressure turbine did not originate, however, for service with the ordinary power stations. It was first put forward practically by Professor Rateau, for use in mining and metallurgical processes, where the consumption of steam was exceedingly wasteful. His solution of the problem was to put a turbine in line with a steam engine which ran intermittently and could therefore not make a good use of condensing apparatus. This involved, in addition, a regenerator, or storage reservoir, for steam, so that the turbine might receive a constant flow while the exhaust into the regenerator was irregular. It also required some method of taking steam from the boiler direct to the turbine. Later experience has demonstrated the possibility of running the turbine in sequence with any steam engine and, hence, the combination of the two



TEMPERATURE ENTROPY DIAGRAM.

seems to promise well for the future. It certainly has recognition in a number of places where its merits will be thoroughly tested.

The name, low-pressure, seems on the whole the most appropriate, inasmuch as it is essentially the low-pressure part of any turbine. It commonly uses exhaust steam from a steam engine, or, in marine practice, from a high-pressure turbine, but for deficiency of power it may take steam directly from the boiler, thus becoming what might be called a "mixed-flow turbine." The principles of design are, however, those applicable to turbines for large volumes of steam at low pressures, whether from the exhaust side of another steam motor, or direct from a boiler, and this fact should fix the name.

A number of papers on the low-pressure turbine have appeared in the transactions of societies and in highly technical periodicals, so that the principles of its action are fairly well understood among engineers; nevertheless, a brief reference to a few fundamental principles is

ventured here for the benefit of the many general readers of THE ENGINEERING MAGAZINE. An excellent description of the Rateau system may be found in the number for November 1907. A diagram similar to that in any book on thermodynamics is given here to show at a glance the available energy in steam for several ranges of pressure. It is generally known as the "Temperature Entropy Diagram." The several areas represent to a scale the available energy per pound of steam. They are made out for steam which enters the engine or turbine just dry and saturated, with an area added to show the effect of superheating. The work, theoretically, in the several cases is:

1. Area CDEF = 138,437 foot-pounds, representing the case of a non-condensing engine or turbine taking steam at 175 lb. [Abs.] per square inch and exhausting it at 15 lb. per square inch.
2. Area BDEG = 204,300 foot-pounds, representing the case of an ordinary condensing engine taking steam at 175 lb. per square inch and carrying a vacuum of 23 inches on the exhaust side of the piston.
3. Area ACFH = 139,663 foot-pounds, representing the energy thrown away by a non-condensing steam engine in case a vacuum of 29 inches were available. In case this exhaust steam were turned into a low-pressure turbine after the moisture had been drained out of it, the area should be equal to 138,000 foot-pounds.
4. Area FEJF′ = 21,800 foot-pounds, representing the energy added in the first case for steam superheated 200 degrees above the temperature due to 175 lb. per square inch.
5. Area GEJG′ = 28,300 foot-pounds, representing the energy added in the second case for the same superheat as in 4.
6. Area HFF′H′ = 12,800 foot-pounds, representing the energy added in the third case for the same superheat as in 4.

The diagram thus shows at once that there is about the same available energy between atmospheric pressure and the best obtainable vacuum as there is between the atmospheric pressure and the highest pressure commonly carried in boilers. This has led some writers to say with very fair accuracy that there is as much work in steam below the atmosphere as there is above. The ordinary steam engine and condensing apparatus cannot in the nature of things take advantage of this, and the great economy exhibited by the steam turbine is wholly due to the fact that it can. The three figures, 138,437 for atmospheric exhaust, 204,300 for condensing steam engines, and (138,437+138,000=) 276,437 for the steam turbine, or the combined steam engine and turbine exhausting into a first-rate vacuum, tell the whole story. It is only fair, however, to call attention to the fact that steam engines sometimes have a better vacuum than that assumed for calculation, and that turbines more often have a 28-inch than a 29-inch vacuum. There can be no doubt, however,

that there is much greater gain from improving the vacuum than has been commonly suspected.

While the steam turbine is admirably adapted to a low vacuum, the steam engine can not make economical use of low pressures, on account of the enormous size of cylinder required. The volume of one pound of steam at 175-pounds pressure is 2.608 cubic feet, and that at ½-pound pressure is 648.6 cubic feet. For example, a compound engine with cylinders 36 inches and 72 inches by 48 inches would require a third cylinder of at least 200 inches in diameter to make use of steam expanded down to ½-pound pressure. Even if it were possible to build and operate cylinders of such dimensions, the loss by condensation, radiation, and friction would more than offset the gain from the use of greater ranges of expansion. Hence compound and triple-expansion engines can never take full advantage of the lower vacuums. On the other hand, the high-pressure part of a turbine cannot make as effective use of steam as the low-pressure part, for two reasons. In the first place, the percentage of leakage by the blades is much greater; and in the second place, the rotation losses due to the higher density of the steam are large. The steam engine and the turbine are then natural companions—one for the high and the other for the low pressures—although it is still extremely doubtful if the two should be designed and built for combined operation in a new station. The place of the low-pressure turbine is thus that of a gleaner in a very wasteful field.

The percentage of the available energy actually realized in practice varies within wide limits, depending upon the conditions and upon the size of the engine. A good performance for the ordinary compound engine is about 70 per cent efficiency in the cylinders, and the return of energy for one pound of dry saturated steam is then $.70 \times 204{,}300 = 143{,}010$ foot-pounds, equivalent to 13.84 pounds of feed water per indicated horse power per hour, or to 20.28 pounds per kilowatt hour, at the switchboard. If the efficiency of a non-condensing compound engine be taken at 66 at the switchboard, the energy actually realized will be 91,368 foot-pounds, and the steam consumed about 29.05 pounds per kilowatt hour. This is a better rate than is commonly met with in non-condensing engines, but the range of pressure is higher.

In case the steam were taken into a low-pressure turbine after having done its work in the steam engine, the energy actually realized in addition to that already yielded at the switchboard, would be about $.68 \times 138{,}000 = 93{,}840$ foot-pounds, thus requiring for the turbine alone 28.28 pounds of steam per kilowatt hour. If the return of energy

from the turbine be added to that from the engine, the feed water per kilowatt hour would be 14.33 pounds. The vacuum has been taken rather better than is to be found in the average turbine station; on the other hand, the efficiencies assumed are below the best that can be realized with engines and turbines of large power. It must be remembered also that when a turbine is placed in sequence with a steam engine, the ordinary condensing apparatus will no longer satisfy the requirements, and the addition of a low-pressure turbine to an old plant means the rejection of the bucket air-pump and ordinary jet condensers and the substitution of more expensive condensing plant.

In studying the possibilities of the combined system, a further consideration of the efficiency of the engine and turbine is necessary. The steam engine will undoubtedly give a larger percentage return of the energy available above the atmosphere than below it. Some cases have been reported where the efficiency ratio for a non-condensing engine has exceeded 80 per cent. Attention has already been called to the reasons why the steam engine fails as a low-pressure machine, with very low terminal pressure. The steam turbine fails also in its high-pressure stages, as compared with its low-pressure stages. This does not mean that more work cannot be gotten out of the combined high- and low-pressure turbine than out of the low-pressure turbine alone, but that a greater percentage of the available energy is actually realized in the latter. The main question, then, on which the great development of the combined system depends will hinge on a comparison of the high-pressure engine with the high-pressure turbine. If the former is superior to the latter, the combination of engines and turbines in sequence will give results as good as, or better than, the best engine alone, or the best turbines. Taking the efficiency of the engine part as 74 per cent at the switchboard, and of the turbine as 72 per cent, the actual amount of energy realized per pound of dry saturated steam would be 201,800 foot-pounds, corresponding to a water rate of 13.15 pounds per kilowatt hour. The use of superheated steam in the further development of this combination may well reduce the water rate considerably below the best yet recorded for steam turbines alone. If this can be realized without undue complication, the low-pressure turbine will find a much wider application than capturing steam going to waste in the atmosphere, or than rejuvenating old steam-engine plants. It may become a strong competitor of other power systems in new stations.

The low-pressure turbine does not seem to present any great difficulty in operation. The condenser and pumps are precisely the same as for any turbine, and experience has shown that a first-rate

vacuum is not much more expensive than a poor vacuum. The exhaust from the pumps can always be led into an auxiliary feed-water heater where most of the heat can be recaptured, so that material increase of steam consumption for auxiliaries is not necessarily heat thrown away. In the worst case, however, the cost in steam and attendance will not be increased in greater proportion than the percentage increase of power due to the installation of a low-pressure turbine; in the ordinary case, it should be very much less. No governor is necessary on the turbine, if the current is delivered to the bus-bar of the steam engine. The two machines adjust themselves easily to each other. When the total load increases or falls off, the cut-off simply changes on the steam engine and the turbine takes the exhaust steam that is given to it. The terminal pressure in the cylinder will vary with the load, however, and it may be necessary in the early stages of design to provide for the light-load condition by increasing the opening through the buckets, or nozzles, of the turbine, in order that the back pressure against the steam piston may never exceed the terminal pressure. The efficiencies on which the water rates have been calculated are good only for the normal, designed load of the machines; consequently, they do not hold for fractions of the load. They will undoubtedly fall off for small loads, as in turbines and steam engines running alone, but unless the machines are unsuited to each other, the combination should not be worse affected than either machine separately. One point that might prove favorable to the combined unit relates to a break-down. Inasmuch as each machine is on a separate shaft, a break-down of one would not put the other out of commission, if each was connected independently to the condenser. The turbine would, for such an emergency, have its own connection direct to the boiler and its own governor.

The fields for the possible application of the low-pressure turbine may be classified roughly as follows:

1.—Steam engines used intermittently on atmospheric exhaust.

2.—Steam engines running continuously on atmospheric exhaust.

3.—Steam engines in existing stations having ordinary condensing apparatus.

4.—Marine propulsion.

5.—New stations in which the steam engine and the low-pressure turbine are designed for combined operation.

1.—The first of these fields is well occupied by the Rateau turbine, one example of which will be given later on. There can be no question of the great gain in this case, where there is a demand for the regular supply of electricity in addition to the intermittent ex-

penditure of power for manufacturing purposes. The only wonder is that some engineer did not attempt to get back some of the lost power by the use of low-pressure steam engines long before 1902, when Professor Rateau first applied his turbine to low pressures.

2.—In this case, there is again no doubt of the saving effected by the turbine. An engine is exhausting into the atmosphere and thereby throwing away as much available power as was developed in the cylinders. The addition of a low-pressure turbine to turn this power into useful channels without increase in the expenditure of coal or steam is a great gain. The power is practically doubled at moderate first cost and small additional attendance. The only question which arises, "Could the steam engine itself not have been designed to get back this wasted power?" must be answered in the negative. As already pointed out, the steam engine cannot in the nature of things make as effective use of low pressures as the turbine. If water for condensation is not available, as in many cases where the high-pressure engine is used, a cooling tower is necessary to maintain the vacuum for the turbine, and this adds to the expense and complication; but, after all, the whole cost of the turbine and all the condensing apparatus is a small matter in comparison with the great saving of coal.

3.—This case covers by far the great majority of old power stations in the United States, and the argument for the turbine as an assistant to the steam engine must be more carefully drawn. Where an engine is developing power at the cost of 13.5 pounds of steam per indicated horse power per hour, or about 20 pounds per kilowatt hour, it is difficult to convince the average board of directors that a low-pressure turbine can be of sufficient advantage to warrant a large outlay to begin with and a risk of troublesome complications in operation afterwards. This is particularly true if a plant is operating satisfactorily and there is ample power for all purposes. If a station must be enlarged, or additional power obtained in some way, the problem is simplified. Yet one is in the face of an alternative even here which has not so far been fully cleared up. Is it not, on the whole, better to add more steam engines for increase of power, or to replace the engines once and for all with steam turbines; and thus, in either choice, to have a uniform type throughout the station? While it can be shown that an old steam engine can be practically doubled in power by the addition of a turbine, without anything like the same proportionate increase of cost in machinery and boilers—furthermore, that an antiquated plant can be brought up to date—there is still the doubt about the operation of mixed machinery in the

hands of the average mechanic. The question of the low-pressure turbine comes down then to its youth, and its adoption as one of the most useful means of obtaining additional power is only a matter of time, if the claims for it, or if the results above worked out, are realized in practice. Going back to the figures for energy available in one pound of dry saturated steam, there are, in the case of the steam engine alone, 204,300 foot-pounds; and in the case of the turbine, or the combined engine and turbine, 276,400 foot-pounds; representing a gain of 35 per cent in power without the expenditure of a dollar on boilers. This gain would probably fall off to 25 per cent or 30 per cent in practical operation, but it would be obtained at an expense limited to the turbine and its accessories. The subsequent running expenses would in most cases remain about the same, so that the cost per unit of power would be reduced enough to pay for the new installation in a few years. In one case, worked out very carefully for a small station, the saving seemed to be enough to pay for the turbine in less than two years. The above percentage of increase does not represent all that can be gained. Any old steam-engine plant can practically be doubled in power by the addition of low-pressure turbines and about 40 per cent more boilers. With this increase, the steam engine must be capable of developing its full power on atmospheric exhaust, and this demands some readjustment of the valve gears for smooth running. Naturally, the conditions of running and the proportions of the cylinders should be known before designing the turbines, so that the two may operate well together. The sequence is essentially the same as that for steam cylinders. A simple engine becomes compound with the turbine, or a compound engine becomes triple expansion; and the cylinders, if designed for the turbine, ought to be proportioned accordingly. To steam-engine builders, this seems to mean that the cylinders of a compound engine ought to be 2½ to 1, if the exhaust is to drive a turbine, and it is possible that experience may prove this to be true; but one point is lost sight of—the turbine will take any pressure, within reason, that is given to it, and there is no necessity of changing the ordinary proportion (4 to 1) of compound engines. However, this is delicate ground, and the actual use of the turbine in the type of station under discussion may serve to modify opinions, inasmuch as the experimental data at hand shed little light on the subject. It may be that a long range of expansion in the steam engine would not be economical with the turbine in sequence, and that, if we ever come to designing the two machines specially for each other, the proportions may be quite different from present practice. The best dividing line may not

be at atmospheric pressure; it may be well above. It ought not ordinarily, to be below, on account of the rapid loss of vacuum with serious air leaks around the stuffing box of the steam engine. So far as the actual running of the turbine itself is concerned, experience in a number of stations has demonstrated its simplicity.

4.—The application of this combination to marine propulsion promises well, particularly for commercial ships of low speed and for national ships of variable cruising speeds. One merchant ship is already giving remarkable results in service and several are in process of construction. The best arrangement seems to be a pair of compound or triple-expansion engines operating twin screws for ahead motion and backing, with a mixed-flow turbine operating a central screw for ahead motion only. The turbine is designed for low rotative speed by having a large number of stages and a highly efficient screw propeller can thus be used. There is absolutely nothing against this combination that could not be urged against any system; on the other hand, for cruising vessels that may be called on for high speed only during brief intervals, it has manifest advantages. The turbine becomes a more wasteful machine than the steam engine when its rotative speed departs much from the normal, and that is just what it does at a cruising speed, or when a heavy head sea changes the hull resistance materially. One would naturally expect this fact to appear in the comparative tests of the scout cruisers, where the reciprocating engines of the Birmingham are in competition with the turbines of the Salem and Chester. The turbines should give better results at high speed, which the cruisers will seldom run; and the steam engine, at cruising speed, which they will generally run for the maintenance of their sea endurance. With a combination, the engines and turbines can be designed for each other and thus give the ship all the advantages of both. The problem of weights has not been worked out and it is not known how much the weight of machinery would be changed for such a system. There are various arrangements possible for the steam piping and condensers, but it is not necessary to go into that here. One plan, which has novel features, has been suggested by several first-rate engineers. It is to have steam engines operating twin screws, and to turn the exhaust into high-speed mixed-flow turbo-generators with comparatively few stages, each propeller shaft to carry variable-speed motors taking their current from the generators. If the steam engines could also exhaust into the condensers when necessary, this system would have marvellous flexibility. Both shafts could be operated on the engines alone, or on the turbines, or on only one of the turbines. The possi-

ble combinations will readily occur to any engineer. Whether the weight would render this plan prohibitive is a question for shipbuilders to work out. Cruising turbines are generally used in warships, but it remains to be seen whether they will really help the turbine to hold the place which the combination of the engine and turbine seems to fit so admirably.

5.—The four cases already discussed involve either exceptional conditions or some special features, like that of rejuvenating old engines; but the fifth brings up the problem of new design. Is it possible to build this combination for competition with the steam engine alone, the steam turbine, or the gas engine? Only the future can answer that question. At present, it seems to be answered in the negative, when the complication of a mixed station is considered. The most that can be said for new work is that the combination promises well for the future and that it may develop superior qualities. But no engineer would be quite justified in adopting it for a new station without experimental proof of these qualities, notwithstanding the fact that a fair calculation seems to indicate very great economy.

A word may be added, while on this part of the subject, in reference to the value of the calculations previously given. They are probably within a small percentage of what can be realized in practice, as they have been carefully compared with actual experimental results. At the same time, attention should be called to several possible differences when the water rates are compared with existing machinery. The vacuum against the non-condensing steam engine has been taken at 23 inches, about what it has been found to measure in several recent tests of large engines. The vacuum for the turbine has been taken at 29 inches, in order to bring out the best that the machine can do. Records of a number of performances show even a better vacuum. A correction of from 6 per cent to 9 per cent addition for every inch of vacuum may be applied to the steam consumption, as given in the calculation. The drop in the receiver is a second element of uncertainty, but it will be relatively small and the correction for it will be unimportant. Another point is the variation of economy with a fluctuating pressure between the engine and turbine. Finally, the maximum efficiency of each machine when the two are operating together may not come at the same load. There is, therefore, a considerable amount of information from actual tests needed to put the whole subject on a reliable basis. Nevertheless, the fact that there is great saving is well established by the calculations and borne out by practical experience.

SYSTEMS OF CHARGING FOR ELECTRICAL ENERGY.

By W. T. Ryan.

THE success of any central station is dependent, to a large extent, upon the confidence placed in it by its customers; hence it is dependent upon the adoption of a fair and equitable method of charging.

In dealing with most commodities, a charge for the quantity delivered is a fair one. A charge of so much a ton for coal, or so much per thousand cubic feet for gas which may be "stored" in large reservoirs, is a fair one. The selling of electrical energy involves conditions seldom met with in any other line of business, which require the working out of special systems of charging. Money must be invested in a station and apparatus to be kept in readiness at all times, such as dynamos, engines, transformers, boilers, meters, etc., which are loaded to their full-load capacity for only a short period each day. If a customer puts on a heavy load for, say, fifteen minutes a day, and does this, say, on the peak of the load, the management must purchase and maintain the apparatus necessary to supply this customer, and depend on him for returns on the outlay.

Within the last few years systems of charging for electric current have been widely discussed. The principal ones in use at the present time may be classified about as follows:

1.—Flat rate.

2.—Meter rate.

3.—Classification of rates.

4.—Wright maximum-demand system.

5.—Doherty rate.

6.—Four C. system.

7.—Double-rate meter.

8.—A charge based on the customer's minimum monthly guarantee.

9.—Combinations of the above.

1.—The Flat-Rate System. Many small electric-light companies supply current to customers at a certain price per month per each

lamp installed. The 16 candle-power lamp is the unit generally employed. This system means a definite charge for a fixed capacity, regardless of the quantity used.

This would work out to rates per kilowatt-hour varying from a very low minimum in cases where the current was used continuously, to a maximum rate of infinity in those cases where no current would be used. This system is popular with the customer because the charges are a fixed amount each month, and the customer knows just how much he will be called upon to pay. The station book-keeping is simplified and the cost of meters is avoided, but the fact that there is no check on the power delivered to a customer makes it obvious that the rate is unjust and entirely void of business principles, since a wasteful customer pays no more than an economical one.

2.—The Meter System. In this discussion the meter system refers to the selling of electrical energy by the kilowatt-hour as indicated by a watt-hour meter, no account being taken of the quantity used.

The development of this system was the next step, and to many customers it appears to be an equitable system of charging. An analysis of this system shows a fixed charge per unit of energy sold, regardless of capacity demand. In this case, the "cost to produce" would vary from a very low cost per kilowatt-hour if the total capacity were used continuously, to infinity if no energy were used. This system is just as absurd as the flat-rate system; neither bears any relation to the cost of service. If as much as $1.00 per kilowatt-hour were charged some customers, their total payment would still be so small that it would not equal the cost of reading their meters, keeping books for their accounts, and the core loss of transformers, to say nothing of the interest, depreciation, taxes, and insurance on the money invested in apparatus which must be had in order to meet their demand.

3.—Classification of rates. A very common method is to classify customers according to their daily regimen in the use of current, and to establish a separate rate per kilowatt-hour for each class. There are two distinct classes of service in most electric plants, namely: (a)—domestic lighting, with its negligible demand during the day and its excessive demand for current during the evening; (b)—motive-power service, with a nearly uniform demand for power all day. Customers of the first class are charged at a higher rate than those of the second class. In addition to those differences in the scheduled prices, quantity discounts are often given, and in many cases there is also provided a minimum charge.

The mere fact that current is at a customer's disposal night or day represents a service rendered; also the interest on the cost of the watt-hour meter, the cost of reading it, and a portion of the cost of the station bookkeeping, represent an expense which justifies a certain fixed charge against him. This fixed charge is often made in the form of a minimum charge.

4.—Wright Maximum-Demand System. The most important of the special conditions involved in the sale of electrical energy is the fact that no adequate method of storing electrical energy economically is in existence at the present time. This necessitates the keeping in readiness, at all times, of the apparatus of the station such as dynamos, engines, boilers, etc., which are loaded to their full capacity for only a short interval each day during the busy part of the year. To keep in readiness this large installation requires a corresponding investment on which a reasonable return for interest, insurance, depreciation, and taxes must be obtained before any profit can be made.

On the straight meter rate, or even with a classification of rates under present limitations, it is practically impossible to charge the short-hour customer a sufficiently high rate per kilowatt-hour to cover the expense to which he puts the producer of power.

A number of leading central station men of the world have devised systems which were intended to make each customer pay in proportion to the "cost of service." Mr. Arthur Wright, of England, was one of the pioneers to go deeply into the question of rates. Mr. Wright divides the cost of electrical energy into (*a*) preparation costs, (*b*) production costs. The preparation costs are again subdivided into (1) formation expenses, (2) stand-by costs, (3) service costs.

(a) The "formation expenses" are those incurred by the necessity of obtaining the initial capital to start the undertaking with. The "stand-by costs" represent the maintenance of the plant and supply mains in a condition ready to supply and distribute energy. The "service costs" represent the maintenance of service wires and meters, the incidental disbursements connected with accounts for supply, attending to complaints, and the collection of bills.

(b) The "production costs" represent the actual expense of continuing to supply and distribute electrical energy. This varies with the amount of energy generated and distributed. The unit of production cost is the "increment of expenditure" incurred by making a given plant and set of mains supply an extra unit of electrical energy.

On this basis the Wright maximum-demand system assumes that each customer should pay the fixed charge on the portion of the plant he uses, and in addition should pay the running expenses only for the hours he actually uses the plant. In order to get the maximum demand made by a customer on the station and to find out who the short-hour customers were, Mr. Wright devised the Wright maximum-demand meter which records the maximum current used by a customer between two readings. This meter is read at the same time as the watt-hour meter. These readings are usually used to get the amount of energy to be charged for at a high rate and the amount at a low rate.

There are three other methods which are sometimes used to get at the maximum demand: 1, By putting the demand equal to the connected load. 2, By estimating the demand. 3, By limiting the demand so that a customer cannot exceed a certain amount.

Briefly stated, the advantages and disadvantages of these different methods are as follows:

Connected Load: No maximum-demand meters. Demand fixed in advance. Unfair basis. Notifications and inspections necessary. Inaccurate determination. Large connected load discouraged.

Demand Estimated: Fair basis. No maximum-demand meters. Demand fixed in advance. Notifications and inspections necessary. Inaccurate determination. Large connected load discouraged.

Demand Limited: Fair basis. Notifications and inspections not necessary. Accurate determination. Large connected load not discouraged. Instruments necessary.

Demand Measured: Fair basis. Notifications and inspections not necessary. Accurate determinations. Large connected load not discouraged. Instruments necessary. Demand not fixed.

The kilowatt-hours used by the customer being known from the watt-hour meter, and the maximum current used at once from the demand meter or otherwise, the matter of arranging the charges may be done in several ways.

One method is to charge a list price per kilowatt-hour and then give, say, 10 per cent discount to customers who average two hours per day use of their demand, 25 per cent discount for three hours per day use of their demand, etc. Another method is to charge a fixed amount per year payable in twelve installments as rent on the investment. In addition, a charge of say 3 or 4 cents per kilowatt-hour would cover the running expenses. The most common method, and the one best adapted to ordinary practice, is to charge, say, 12

cents per kilowatt-hour for the first 60-hours (2 hours per day) use of the maximum demand, and say 4 cents per kilowatt hour for the remainder.

Suppose, for example, that the maximum-demand meter reads 10 amperes on a 110-volt circuit, and the watt-hour meter reads 100 kilowatt-hours. On a two-hour per day basis, a primary rate of 12 cents per kilowatt-hour and a secondary rate of 4 cents, the customer's bill would be figured as follows:

$$\frac{10 \times 110 \times 2 \times 30}{1{,}000} = 66 \text{ kilowatt-hours.}$$

The amount to be charged for at the high rate would be 66 kilowatt-hours, and the amount to be charged at the lower rate would be 100 — 66 = 34 kilowatt-hours. The customer's bill would be:

$$(\$0.12 \times 66) + (\$0.04 \times 34) = \$9.28.$$

This is an excellent method except for one reason. If the customer's meter had read, say 20 kilowatt-hours, his bill would have been:

$$20 \times \$0.12 = \$2.40.$$

Evidently he would not pay his share of the fixed charges.

5.—Doherty rate. According to Mr. Henry L. Doherty, the costs are fixed: 1, By the number of customers. 2, By the distance of the customers from the station. 3, By the capacity they demand. 4, By the amount of their consumption.

The distance from the station is influenced by the location of the station, hence it would seem that there would be no reason for varying the cost to different customers because of varying distances from the station except in extreme cases.

There are certain costs such as bill making and meter reading which are entirely fixed by the number of customers, and many other costs (as for example meter testing and maintenance, office rent, superintendence and inspection) which are virtually fixed by the number of customers. In order to cover these there should be a fixed charge for each customer regardless of his consumption or the size of his installation provided only one meter is installed.

The costs such as interest, insurance, depreciation, and taxes, which are fixed by the capacity demanded, are covered by a "stand-by" charge for each equivalent 50-watt lamp of the customers connection.

There are still other charges which are fixed by the quantity of current generated, such as fuel, oil, lamp renewals, etc. In order to

cover these charges there should be a fixed and uniform rate per kilowatt-hour consumed.

The maximum demand on a station is usually from one-third to one-half the load connected. The cost of the station and the lines leading out from it usually lies between $200,00 and $600.00 per kilowatt installed.

A fair value for the stand-by charges, which include interest, insurance, depreciation, and taxes, would be 12 per cent. A fair value for the fixed charges, which include office expenses, reading meters, rendering bills, etc., would be, say 3 per cent. If the plant costs $400.00 per kilowatt installed, and the maximum demand is one-half the connected load, the annual stand-by charges plus the fixed charges would be $30.00 per connected kilowatt. If a customer uses 50-watt lamps, the annual stand-by charge plus the fixed charge per 50-watt lamp connected would be $30.00 divided by 20, or $1.50. This would be $0.125 per month. Hence a customer should pay 12½ cents per month per equivalent 50-watt lamp connected, whether he uses any power or not. In addition to this he should pay for the power he uses.

6.—Four C System. This system derives its name from its method of charging. It consists of a capacity charge and a current charge —four Cs.

The average cost of capacity of the plant is found by the formula:

$$C = \frac{F}{N}$$

in which

F = fixed charges per annum on unit cost of plant,

N = number of 50-watt lamps per unit,

C = average capacity charge per annum per lamp.

After obtaining the average capacity charge, a maximum and minimum charge per lamp is determined on a sliding scale.

In this system the fixed charges include all the charges except the production costs, and are apportioned among the various customers in proportion to the length of time they use their energy. It is evident at once that any system which charges as much rental to a short-hour customer as a long-hour one, gives the latter the advantage, and discourages the growth of the industry.

While it is perfectly consistent to expect the customer to reimburse the station for all fixed charges that have to be met to furnish him with the service he requires, the proposition is necessary only to

insure the station against loss in carrying capacity for him. It is not necessary or desirable to charge the full amount shown as being fixed charges in order to get this protection. The object is accomplished when a large proportion of the fixed charges are guaranteed, and besides it is not probable that all the consumers will demand their maximum contracted capacity at the same time.

7.—Double-rate meter. The double-rate meter is an ordinary watt-hour meter equipped with two sets of dials and a clock which throws into gear one set of dials during the period of excessive loads, and another set of dials during the remainder of the twenty-four hours each day. The customer is charged a high rate per kilowatt-hour for the energy indicated by the first set of dials, and a low rate for the energy indicated by the second set. Obviously such a system would promote long-hour consumption.

An ordinary meter may be used by inserting a resistance in an auxiliary circuit at the central station, at the hour when the low rate is to begin, and maintaining it there until the end of the low-rate period. This resistance retards the speed of the meter, to a degree representing the ratio the low rate bears to the high rate.

This method reduces the expense of meters. It has the disadvantage of not being so easily understood by the average customer. The chief difficulties in the way of the double-rate meter method based upon the time of demand are the absence of suitable mechanical appliances, by which two meters or two set of dials can be controlled in such a manner as to protect the company against fraud, to secure accuracy, and to avoid material increases in fixed charges. While this method would tend to broaden the peak, it would also tend to reduce the use of light in the business districts where light is very essential and where it is used at a time when the rate would be doubled or tripled. It would mean a reduction of lighting of such places, or the use of illumination other than electric, either of which is undesirable from the stations' standpoint.

8.—A Charge Based upon the Customer's Minimum Monthly Guarantee. In a recent bulletin published by the Union Electric Light & Power Company, of St. Louis, a novel system of rates is explained in a manner calculated to be understood by the general public. Under this system the service is divided into a very large number of classes and each customer in the same class gets the same rate. The customer's rate is based on the minimum monthly guarantee he is willing to make per horse-power or per 50-kilowatt lamp connected. The rate is also lower the larger the connected load. For example: a cus-

tomer having less than 100 lamps pays 12 cents per kilowatt hour if he guarantees only 10 cents per month per equivalent 50-watt lamp. If he guarantees 65 cents per month per equivalent 50-watt lamp, his rate is 8 cents per kilowatt hour. Between the 10- and 65-cent limits there are 15 intermediate steps. If the customer has a connected load of over 3,000 lamps and will guarantee only 10 cents per lamp per month, his rate is 6 cents per kilowatt-hour. If he will guarantee 50 cents per lamp per month, his rate is 5 cents per kilowatt-hour. There are twenty-five steps between a connected load of less than 100 lamps and over 3,000. A customer whose connected load is under 100 lamps and who guarantees 65 cents per month per lamp, gets the same rate as a customer who has between 1,000 and 1,250 lamps connected and who guarantees only 10 cents per month per lamp. A table has been worked out giving the rates in cents per kilowatt-hour for connected loads varying from less than 100 lamps to over 3,000, and for minimum monthly guarantees per lamp per month varying from 10 cents to 65 cents. These rates are subject to a farther discount based on hours used and quantity.

The power rates are on the same plan. A customer whose connected load is one horse power pays 10 cents per kilowatt-hour if he guarantees $1.00 per month per horse power. If he guarantees $7.50 per month per horse power, he pays 5 cents per kilowatt-hour. There are a number of intermediate steps between the 5- and 10-cent rates depending on minimum monthly guarantees, as in the case of the lighting rates.

This system has some very marked advantages. It is difficult for customer A to say that there is discrimination in favor of customer B, for if A will connect the same load and make the same guarantee as B he will get the same rate. It strongly encourages larger connected loads and longer hours use of both light and power by all customers at all time. It means that the customers in their anxiety to get as low a rate as possible will insure the company of a large percentage of their gross earnings.

9.—Combinations of the Above Systems. Many central-station managers find it necessary to work out a system of charging to suit their particular installations which are a combination of two or more of the above systems. It is very difficult to work out a system of charging for electrical energy which will be fair and equitable, be easily understood by the layman, and at the same time will induce all customers to increase their consumption economically to themselves and with profit to the generating company.

MACHINERY FOR THE MAINTENANCE OF STREET PAVEMENTS IN PARIS.

By Jacques Boyer.

The study of the problems of road and pavement construction has received a tremendous impetus during the past few years through the development of the high-speed automobile. The great increase in wear of road surfaces subjected to constant use by these machines over that caused by horse-drawn vehicles, and the no less important aggravation of the dust nuisance have imposed on urban authorities the necessity of evolving new materials and improved methods. In this particular department of civic administration Paris has long held the foremost place among the cities of the world; that she is in no danger of losing this distinction is amply shown by M. Boyer's review of the latest developments in methods and machines for pavement construction and repair and for street cleaning.—THE EDITORS.

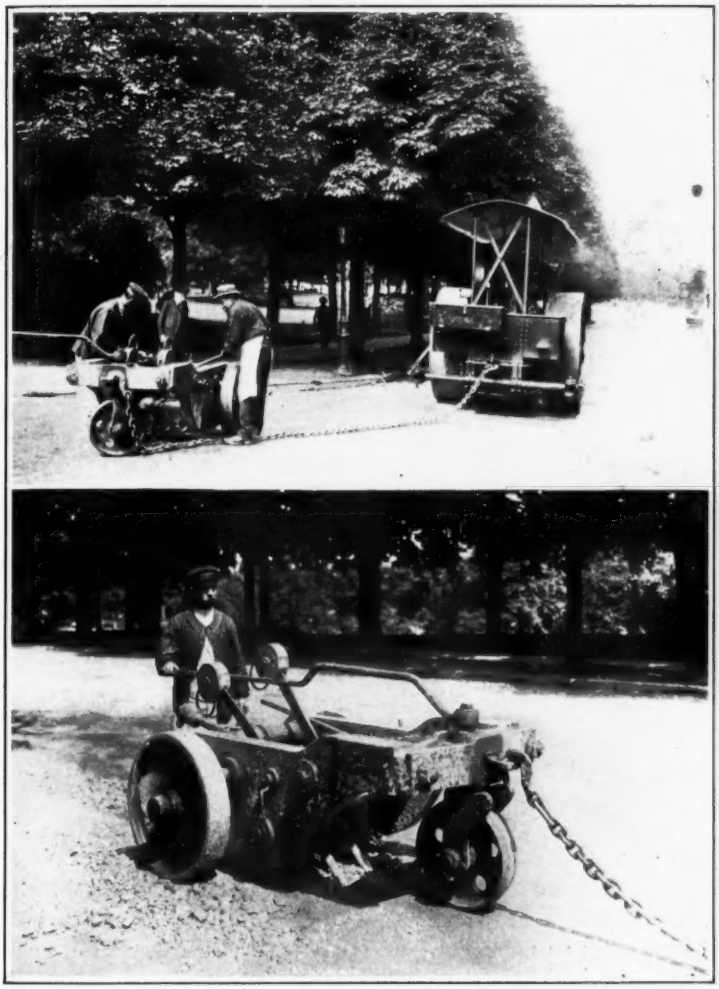
THOSE engineers whose charge it is to see that the streets of Paris are kept in good condition have discovered that their task grows more difficult from day to day. The citizens of "la ville Lumière" demand that their public ways shall be most carefully maintained and kept clean, for this seems to them but child's play. Nevertheless, very difficult problems must be solved to satisfy the taste of the householders, to conform to the laws of modern hygiene, and to preserve good living conditions over a total area of 16,913,250 square metres, of which 7,198,160 square metres are sidewalks and alleys. Beyond this, reckoning must be made with the new "autobuses" now running in the Paris streets which wear the pavement as much as three or four old-style buses; in fact, it has been calculated that a line of these automobile vehicles, each weighing 6 to 7 metric tons when fully loaded, running at 20 to 25 kilometres an hour under a 3-minute headway, is equivalent from the point of view of road wear to an unbroken procession of horse-drawn omnibuses filled with passengers and moving at a walking pace.

The able technical staff has therefore been employed in finding the best methods for meeting all the existing conditions. It is the purpose of this review to show how the streets of the capital are maintained, to review the measures tried in recent years for their improvement, to describe the new machinery which has been employed for this purpose, and to draw the conclusions which seem to be established by all these efforts, comparing them with the results obtained in the large cities of other lands.

Many types of pavement are to be found in Paris, but the principal ones are macadam, stone block, asphalt, and wooden pavement. Although macadam or metaled pavements appear now to be rejected for corresponding situations elsewhere, and although the engineers of Paris endeavor to reduce the extent of this pavement year by year, there were still in 1906 1,178,710 square metres of macadam streets in the entire city.* Furthermore, effort is constantly made to improve the quality of the construction employed. For material, porphyry is used where the traffic is the heaviest and most rapid, broken grit where the wear is less, granite or sandstone for still lighter traffic, and gravel for streets which are very little used. Moreover, there has been almost complete abandonment of the system of partial repairs which consists of filling breaks in the pavement with gravel which is afterwards rammed. The whole surface of the road is allowed to wear down to the repair point, and when this moment is reached the entire surface is restored with new material. As preparation for this general repair, however, it is necessary to dress the surface. For this purpose the public highway service since 1906 has employed picking or harrowing machines on the Zettelmeyer and Bobe systems. The former, shown in Figures 1 and 2, is formed of a solid cast frame resting upon three wheels, the two rear wheels being set upon a transverse axis, traversing the slotted block in which picks are tightly held by means of screws. The forewheel is pivoted and the operator stationed in the rear can steer the machine at will by means of a long lever. Handwheels operating a toothed quadrant through gearing change the angle of the picks so that they may scratch furrows of the desired depth as the machine is dragged along by a steam roller. The Bobe machine, like the Zettelmeyer, weighs 3,500 kilogrammes. Without entering into detail of description, it carries three picks and may be horse-drawn. It is worthy of note that in the Paris streets this dressing of the surface need not go to great depth, especially where, as shown in Figure 3, the surface layers rest upon a foundation of reinforced concrete.

This mechanical harrowing is designed to secure the most intimate bonding of the surface layer, which is then rolled down. For this latter work steam road rollers made by Albarret of Liancourt are employed. In this type (Figure 4) the motor system is carried upon four wheels, two in front almost touching, and two behind, of which one is the driving wheel operated through gearing. The boiler rests upon the forward truck, composed, as already mentioned, of

* All statistics given in this article refer to the year 1906, the administration not having yet published the figures for 1907.



FIGS. 1 AND 2. MACHINE FOR DRESSING OR HARROWING THE ROAD SURFACE, WITH THE AUTOMOBILE BY WHICH IT IS DRAWN.

two roller wheels. These revolve loosely upon a steel axis supported at its outer ends in cast boxes, which are attached to a forged bar solidly united with the king-pin. A cast sleeve is slipped onto the steel axle between the hubs of the rollers, keeping the rims of these two wheels a few millimetres apart. Other cast sleeves are fitted be-

tween the outer faces of the hubs and the axle boxes. These rings serve to keep the faces of the roller wheels always parallel in spite of wear on the journals or brasses. Further, a connection worked by a worm gear and a chain, as shown, serves to swivel the front truck at any desired angle, and the roller is reversing. Three models are made, weighing respectively 12,800, 13,800 and 15,800 kilos. The old horse rollers are no longer employed except in streets too narrow for the steam roller to operate.

FIG. 3. LAYING PAVEMENT ON THE REINFORCED CONCRETE ARCH OVER A SUBWAY PASSAGE OR DRAIN.

The most interesting innovation in recent years, however, so far as concerns the metaled streets of Paris, is the tarring, which, among other advantages, makes them easier for haulage and suppresses almost entirely the dust clouds which formerly were raised by every passing automobile. Many products were tried; first came petroleum, but this has an unpleasant odor, is expensive in France, and gives only short-lived results; therefore it has been abandoned. Next followed divers compositions (westrumite, pulveranto, asphaltine, rapidite, injectoline, odocreol, etc.), of formulæ kept secret by their inventors, but composed for the most part of the heavy oils of coal tar or of oil residues rendered miscible by some saponifying agent. These solutions check evaporation more or less and no dust will show for a number of days. Thus they are often serviceable to the municipal administration of Paris on special occasions, as on race days, reviews.

and other fêtes during which, on account of the crowds in the streets, it is necessary to suspend for some hours the ordinary sprinkling.

Of all these many products tar alone (suppressing dust and consequently mud) has given good results. Let us review rapidly the technical operations of tarring. First of all it is necessary to prepare the pavement carefully, to submit it to vigorous sweeping to remove every trace of dust, and to clear the joints of the metaling in order to allow the tar to penetrate as far as possible. For this purpose, use is made either of mechanical sweepers or of very stiff brooms. The tar is then brought conveniently near in wheeled tanks containing about 3,500 kilos (Figure 5). From these it is transferred to heaters, for when cold it is too viscid to spread easily, while at a temperature near its boiling point (80 to 85 degrees C.) it is almost as fluid

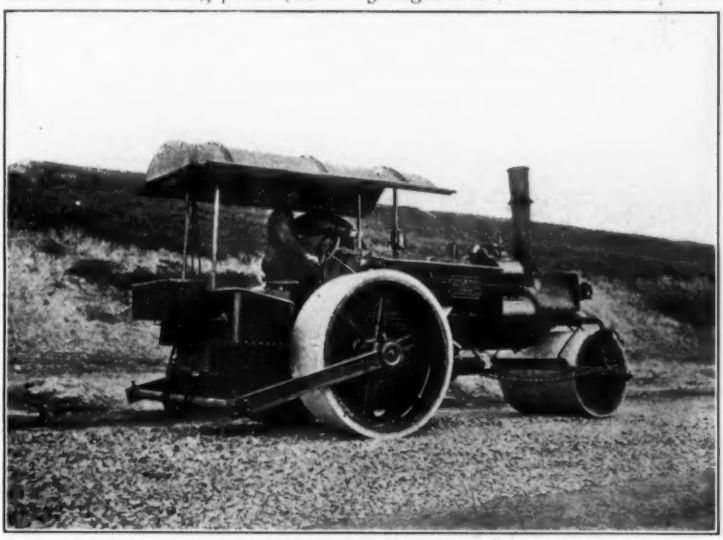
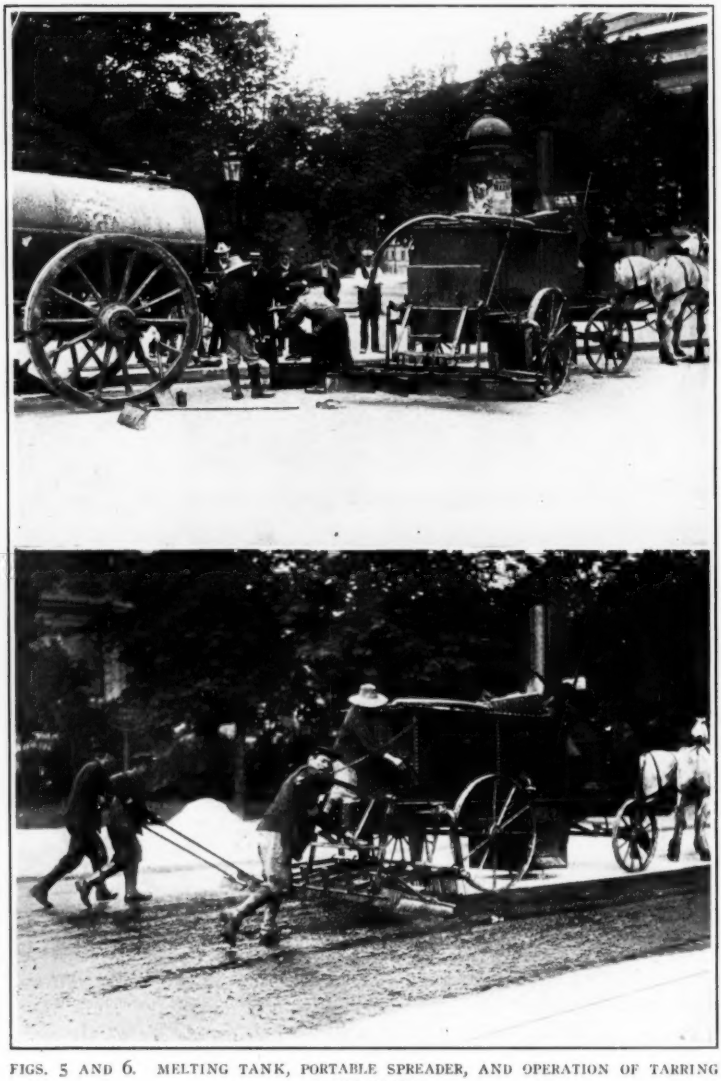


FIG. 4. STEAM ROLLER WORKING ON MACADAM ROADS NEAR THE FORTIFICATIONS OF PARIS.

as water. Nevertheless, certain precautions are necessary, for it foams like milk, froths and overflows the receptacle; furthermore, it takes fire on contact with flame. Therefore, attentive oversight of the heating is imposed upon the operatives. In the apparatus shown in Figure 6, 2,000 to 3,000 kilos of tar may be brought up to the desired temperature. A spraying device and a train of brooms secure a good distribution, which is further perfected, especially on the sides, by sweepers. These latter, with hand brooms, follow a tarring tank whenever it is in motion.



FIGS. 5 AND 6. MELTING TANK, PORTABLE SPREADER, AND OPERATION OF TARRING A ROADWAY.

Another type of machine, invented by MM. Vinsonneau and Hédeline, also appears highly practical. The tar pumped continuously from the containing reservoir passes through a thermo-siphon

heated by oil flame and reaches the receptacle at the necessary temperature, which is thereafter maintained by an internal heater. A compressor maintains uniform pressure within the closed receptacle during the entire progress of emptying. There is thus no danger of fire, the tar being heated and kept in completely closed tanks. Further, this system does not include any distributing sprinkler nor arrangement of brooms. A special adjustment permits the tar to be spread in the form of sheets, instead of in threads as in the preceding apparatus. The sheet of tar is spread upon the roadway like a piece of fabric unrolled. The machine must go twice over the ground, as a single passage does not cover the road completely.

FIG. 7. STONE-BLOCK PAVING.

According to figures given in a work by M. S. Jousselin, tarring prolongs the life of the pavement from one-quarter to one-third. It costs in Paris about 0.15 francs per square metre, and, indeed, recent trials in which the tar was spread cold gave still lower costs. In this case heavy oil was added to the coal tar and the process gave satisfactory results, but the technical officials are not wholly decided as to the value. To avoid necessity of returning to the topic later, it may be noted here that some wood-paved streets have also been tarred. In these cases it rests with future experience to demonstrate the advantage or the needlessness of the process.

Stone-block pavement is of very ancient origin, and although the use of it is restricted year by year, nevertheless streets thus paved

still aggregate 5,637,120 square metres in the city of Paris. This paving is done by hand, and by primitive processes. A layer of sand from 10 to 30 centimetres thick, according to the nature of the ground, is first spread. The workman then sets the stone blocks upon this with the aid of a hammer, which carries on one side an ogival trowel for leveling the sand, and on the other a heavy boss for tapping down the upper faces of the paving stones (Figure 7). The work is finished by filling the joints with fine sand, and the whole paving is then rammed with wooden rammers, iron shod at the lower end, and fitted with two handles by which they are raised and dropped.

FIG. 8. RAMMING NEW ASPHALT WITH HOT IRON RAMMERS.

This type of paving is still much favored in Germany. It is not the practice there to set the paving blocks on sand, but on reinforced concrete, or if the traffic is heavy and important, upon a surface formed of large flat stones over which is spread a layer 0.20 metres thick of crushed stone and gravel, the whole foundation being rolled in the same manner as the macadamized roads of France. Further, to reduce the cost of the foundation, the road builders in Germany sometimes employ reinforced-concrete flags, made in advance. These slabs, 1 metre long, 0.5 metres wide, and 0.05 metres thick, are laid upon other similar flags, and where it is necessary to open a street they can be readily lifted and relaid. This type of foundation is very economical, and very stable for stone-block paving.

In England, precaution is taken to bed stone pavements in cement mortar, and the joints are carefully filled with a thick grouting of tar. Stone pavements thus built are not much noisier than asphalt, and are cheaply maintained and repaired.

The total surface of asphalt paved streets and squares in Paris is but 416,470 square metres, while in Berlin and in London asphalt paving is being extended. It has, indeed, many advantages, being impermeable, noiseless, easily repaired, and possessing every hygienic requisite. It has the sole defect of becoming terribly slippery when the surface is somewhat damp. Nevertheless, when asphalt is completely dry or thoroughly wet it causes no more accidents to pedestrians, cyclists, horses, or automobiles than occur on metaled roads.

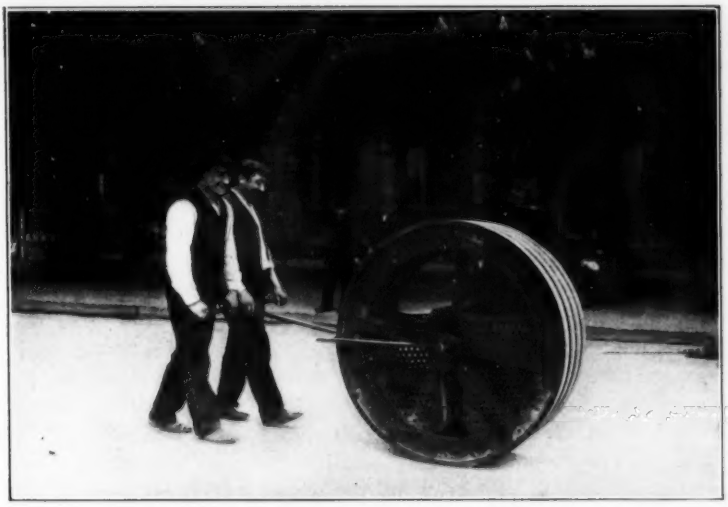


FIG. 9. ROLLING ASPHALT PAVEMENT.

In France, preference is given to the use of powdered asphalt, which is heated in advance in the factory, and spread upon a concrete surface. The granular mass is then pounded down with round cast rammers weighing about 10 kilogrammes, which are heated in a portable furnace. As shown in Figure 8, the laborers performing this work move slowly side by side in a line slightly oblique to the axis of the roadway. Having gone once over the section, they return, working in like manner in the other direction, but pounding a little bit harder; continuing thus and increasing the drop each time, the ramming is completed with the third operation. Other men then go over the rammed surface with hot smoothing tools for the purpose of ef-

facing the marks left by the rammers. When the asphalt begins to cool it is rolled down with a cast roller weighing about 500 kilogrammes, handled by two workmen. (Figure 9.)

In Germany, in order to secure a more uniform density than can be obtained with sheet asphalt, certain cities, as, for example, Frankfort, Cologne, and Hanover, use almost exclusively asphalt blocks made in the factory. In the manufacture of these, calcareous asphalt or so-called American silicious asphalts are used indifferently.

For some time past the attention of Parisian engineers has been drawn to reinforced asphalt, a new paving process designed by M. Arthur Metz. This consists in incorporating an aggregate of crushed granite in the asphalt matrix. The material thus secured shows a durability comparable to that of the hardest rocks. In laying this pavement, a concrete foundation is first prepared and the granitic asphalt is poured over this upon a bed formed of little granite pyramids (Figure 10) which are set by hand in an elastic bituminous coat adhering to the concrete foundation and forming a solid mass with it. It is actually a granite reinforcement which gives to the completed structure the name "reinforced asphalt." Pavements laid under this system (among others, on the Quai aux Fleurs and in several Paris streets) gave excellent results. The thickness of the asphalt layer is from 5 to 7 centimetres for roadways and only 20 millimetres for footways. The wear of the granitic asphalt appears to be slow and uniform, thus permitting its use under dense traffic. Furthermore, it does not soften under solar heat and the surface gives such good adhesion that it is used with advantage and economy on a steep grade (3 per cent) in the neighborhood of the freight station of the Paris-Lyon-Méditerranée railway, where very heavy vehicles are constantly passing. The maintenance and repair of reinforced asphalt are most simple, for instead of tearing up the whole surface for renewal it suffices to spread a new layer of proper thickness, as this unites perfectly with the old surface. The cost of laying this pavement for which a most promising future appears to be assured, is but 14 francs a square metre for roadways and 5 francs for sidewalks (about $2.20 and $0.80 respectively per square yard).

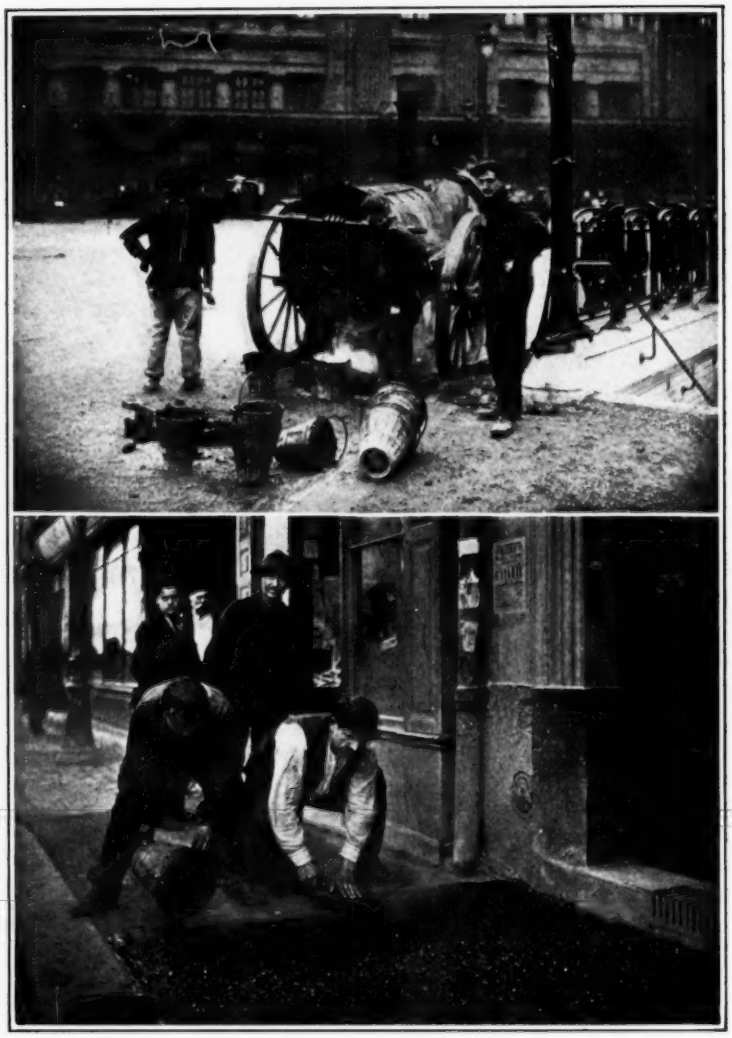
By way of record, mention may be made of the recent and especially unfortunate trial of reinforced concrete in front of the Conservatoire des Arts et Métiers. Upon the foundation of concrete and asphalt already existing, little iron prisms were spread in courses and the whole was covered with a rich cement mortar. At the end of a very short time the experience was conclusive. The cement, wearing away much faster than the iron, left the metal projecting; horses

traveled with great difficulty over the corrugated surface, to say nothing of the noise made by the vehicles, which proved much more intense over the reinforced concrete than over the neighboring stone pavements. The administration was therefore compelled to ask the inventor to remove his new pavement as quickly as possible.

FIG. 10. LAYING THE GRANITE PYRAMID FOUNDATION FOR A REINFORCED-ASPHALT PAVEMENT.

Melted asphalt, better known in France under the name of bitumen, is much employed in Paris for the paving of sidewalks. A mixture of bituminous cement and sand is usually melted in portable heaters, (Figure 11); a small fire maintains the temperature, and the operator in charge keeps constantly turning an agitator with which the machine is provided, so as to prevent the sand from sinking to the bottom. The melted material is drawn into buckets through a gate at the rear; the workman pours the soft mixture in front of the paver, who rests upon one knee, protected by a suitable cover, and spreads the mass with the aid of a wooden trowel. (Figure 12.) Finally, while the bitumen is still warm, fine gravel is spread over the surface and this penetrates and hardens the mass.

While wood pavement is now used over an area of 1,996,610 square metres in Paris, and is being continually extended, other countries condemn it. In Germany thirty-four cities which tried it have now completely abandoned it. In France, the Landes pine continues



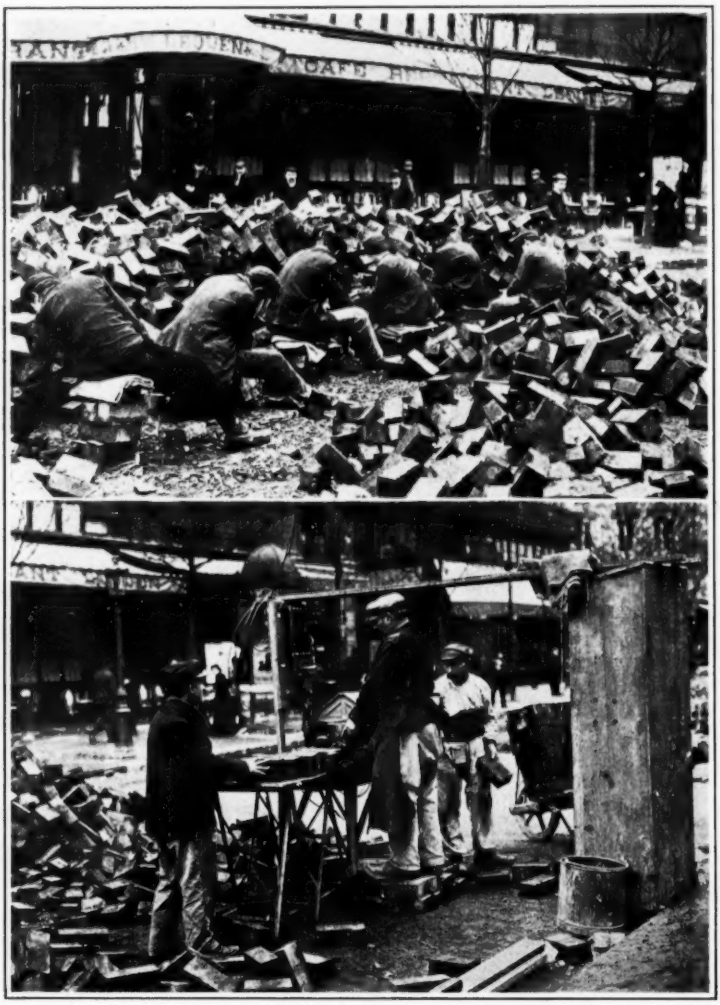
FIGS. 11 AND 12. PORTABLE MELTER FOR BITUMEN, AND PROCESS OF LAYING A BITUMINOUS SIDEWALK.

to be the wood chiefly employed, together with pitch pine and northern fir. These woods are cut into blocks of varying length in a municipal factory, and they are then creosoted. The paver sets them with the aid of a hatchet (Figure 13) on a concrete foundation, in rows

separated by uniform joints whose width is regulated by wooden battens placed temporarily between the courses. As soon as the paving-blocks are properly assembled the battens are removed, and over the surface is poured a mixture of melted tar and bitumen, which runs down into the joints and fills them to a depth of three or four centimetres. The wood blocks are thus imbedded at their base in an impermeable, antiseptic layer. The joints are then filled up with cement mortar made so thin that it can be poured upon the streets and brushed in with brooms. When the pavement is completed the entire surface is covered with small sharp gravel, thus solidifying and hardening the work. Sidewalks are bordered by two parallel rows of blocks at a distance of four or five centimetres, the intervening space being filled with sand or clay to avoid displacement of these curbs by the swelling of the wood.

FIG. 13. WOOD-BLOCK PAVING, SHOWING HOW BATTENS ARE PLACED BETWEEN THE COURSES.

The maintenance of a wood-paved street demands one or other of the following operations: First, reversing, which consists in turning the worn blocks upside-down; second, repair, or renewal of small areas which have suffered more than the average; third, renewal or complete reconstruction. Whatever system is followed, the trimming or dressing of worn surfaces is necessary. To explain this: When a paving block has been in place for some time, the ends of the outer fibres are crushed by the passage of vehicles, and the fringes or



FIGS. 14 AND 15. HAND AND MACHINE DRESSING OF USED WOOD BLOCK FOR PAVING.

brushes thus created must be removed so that the blocks which are still heart-sound may be used again. After cleaning and sorting (Figure 14) this trimming may be done by hand with a hatchet, or, better, on a machine. Figure 15 shows the apparatus devised by M. Josse at work in a Paris street; its essential part is a cutter mounted on a table, and driven by a dynamo fixed upon the same axis. This

cutter consists of a large wheel with six teeth, upon each of which a movable rectangular blade is fastened by two set screws. This permits the easy removal of a dull blade for resharpening. The motor is connected with a municipal electric circuit, and a rheostat placed in front of the operator permits him to start, stop or control the machine at will. One man with two helpers will easily dress 600 blocks an hour by machine, whereas with the hatchet he could not handle more than 50 in the same time. There is also another type of trimming machine in use operated by a de Dion-Bouton motor.

Unfortunately, the first cost of wood pavement is high. In London it averages 21 francs a square metre, using English soft woods, and 25.50 francs for jarrah, teak, and other foreign hard woods. In Paris it figures about 14 francs a square metre. In Germany it approximates 21 francs a square metre, with native soft woods, and exceeds 36 francs with hard woods. This type of pavement lasts from four to five years on heavily traveled streets, and is rather easily maintained, although at greater cost than stone pavement.

We have seen how the Paris streets are built; it remains now to consider the methods adopted for cleaning them, and the provisions made by the administration for the comfort of citizens and for conformity to the modern standards of hygiene. The brief summary will deal particularly with new ideas of special interest to engineers.

FIG. 16. NEW HORSE-DRAWN SWEEPER IN THE PARIS STREETS.

FIGS. 17 AND 18. NEW AUTOMOBILE SPRINKLING SWEEPER.

The sweeping of the Paris streets is done either with a hand scraper fitted with a rubber strip, or by large horse-drawn or mechanically propelled sweepers. M. Mazerolle conceived the idea of combining the ordinary broom sweeper with a scraper fitted to the same machine. (Figure 16.) The idea seems simple, but a slight mechanical difficulty was encountered. The scraper does not actually give satisfactory results except when it is pushed by the hand of the workman. If it is dragged, the least obstacle raises it and it jumps, unless it is very heavily loaded, and in this case the rubber quickly wears out. If, on the contrary, it is pushed, its adhesion to the ground is assured. M. Mazerolle, therefore, arranged in the rear

FIG. 19. OLD-STYLE WATERING CART.

of his machine three scrapers operated not by traction but by propulsion. For this purpose he added a special frame supported by a friction roller, and the motive force is thus transmitted to the scrapers from the rear forward, so that each one acts as if it were pushed by hand. Further, the three scrapers are set at different angles so that they correspond to the ground of the roadway. They are controlled by a special lever convenient to the hand of the driver, who raises them when, for example, the machine leaves a wood to work upon a stone-paved surface where the rubber scrapers would be of no effect.

The new automobile sweeper and sprinkler (Figure 17) recently put into service, shows important progress in the same line of ideas.

FIG. 20. IRON WHEELBARROW FOR REMOVING SWEEPINGS.

The reservoir has a capacity of 2,670 litres. It is equipped with a de Dion-Bouton two-cylinder combustion motor of 15 to 17 horse power, with radiator, circulation pump, and a six-vaned ventilating fan, belt-driven, and magneto-ignition. In order to reduce the length of the vehicle to the minimum, the revolving brushes are installed between the axles. The chassis, 4.37 metres long, is built of steel sections, and to save space the driver's seat is placed between the motor and the tonneau. Besides the ordinary levers and pedals, the operator has close to his hand a handle for control of the sprinklers or sprays, and a wheel operating the distributing cock.

Sprinkling is effected through two valves of controllable discharge, to which the water is supplied by a centrifugal pump. Power for this is taken from the motor shaft between the speed changing gear and the clutch; the pump is thus driven in proportion to the speed of the sprinkling vehicle, even when the motor is disconnected. The drive for the pump and for the revolving brushes is concentrated at one point close to the motor. Motion is taken from the main shaft by cone-gears, driving a countershaft which operates a speed-reducing gear through which is driven the secondary shaft carrying the sprocket of the chain-drive to the revolving brushes. These make 65 revolutions when the motor is running at 1,400, equivalent to the speed of 15 kilometres an hour. Another shaft carrying a friction clutch with expanding segments is driven by the countershaft and is directly con-

nected with the axis of the centrifugal pump; from this latter, which revolves at the same speed as the motor, the water is discharged at a pressure of about 1 kilogramme through a several-way cock. A hand-wheel controls the quantity of water discharged, and supplies at will any one of the sprinkler boxes, including the two shown in Figure 18. Each of the perforated pipes has twelve conical outlets.

With this new device sweeping and sprinkling are effected under conditions comparable to those secured with horse-drawn machines. According to M. E. Bret, of the municipal engineering service of Paris, the sprinkling sweeper can clear 100,000 square metres a day, while horse machines would sweep but 36,000 square metres in the same time. The automobile machine, therefore, equals the work of three horse sweepers. The advantage is not so marked in the matter of sprinkling, although, thanks to the power of the pump, it reaches twice the capacity of the ordinary horse machine (Figure 19). On account of the stops necessary for filling, the machine is actually at work but half the time. The new apparatus thus loses a large part of the superiority which its speed seems to confer, and it distributes but about 58,000 litres of water approximately per day. Horse sprinklers reach a maximum of 27,600, but in ordinary practice the daily average does not exceed 18,000 or about one-third of the duty of the automobile. Work done by the new sprinkling sweeper costs a little more, but in speed and convenience it outclasses the horse machines.

Mechanical sweeping is employed in almost all the Paris streets, whatever their type of pavement, but it renders the greatest service on macadamized or stone-paved surfaces. On the other hand, the rubber scraper effects a more thorough cleansing of smooth pavements and sidewalks. Furthermore, street cleaners sweep up the leavings by hand. For gathering up and removing all these sweepings, a little iron wheelbarrow with a tipping bucket filler has recently been devised as shown in Figure 20.

The household wastes from residences in Paris are set out in the morning upon the sidewalk in movable receptacles, and are taken away by carts which deliver them either to the three incinerating and grinding plants established by a fertilizer company in the suburbs of Paris, or to railroad and water transportation by which they are carried to distances up to 100 kilometres from the capital. The volume of material of this kind removed from all streets of Paris in 1906 reached 1,323,686 cubic metres, of which 1,110,772 was taken by cart, 183,071 cubic metres by railway, and only 29,843 cubic metres by water. It may be added in conclusion that the repair and cleaning of public ways in Paris in that year cost 25,983,571 francs.

THE PRACTICAL TRAINING OF MECHANICAL ENGINEERS.

A COMPARISON OF GERMAN, ENGLISH, AND AMERICAN METHODS.

By Franz zur Nedden.

MUCH has been published in recent years concerning the practical training of mechanical engineers, some of the important communications on the subject having appeared in this Magazine; but these observations related principally to English or American institutions and conditions. In Germany, the conditions for the study and practice of technical science are wholly different; nevertheless, examination of the widely-noticed "Report to the Institution of Civil Engineers" upon the best methods for education and training in all branches of the profession, shows a striking agreement in essentials with the latest Continental opinions upon the same subject. The reason for this agreement may be that this report looks forward to an eventual reorganization of the training in the English polytechnic schools upon models drawn from the German institutions at Charlottenburg.

This, in brief, is the training of a German (*diplomate*) engineer: Boys usually leave school at the age of eighteen years. By the statutes of all German technical colleges, candidates for admission must first pass through a year of practical work in a machine shop or factory. The railway shops of the Government are in part placed at their disposal and during this time they are called *volontairs* or *élèves*, not "apprentices." The name indicates that their aims are wholly different from those of the apprentices. This year of practical work is followed by four years of study in the technical college.

Each year the so-called "long holidays" (that is, a period of about three months) may be used for additional practical training in machinery establishments. There are no shops for special training in the colleges, but from year to year the mechanical laboratories are becoming more important in the whole plan of instruction. A preliminary examination is given after the first two years of study, and success in passing this is a necessary condition for entering the final examination at the end of the course. Both examinations are optional, but as a rule they are taken. If these are successfully passed,

the graduates receive the official title of *diplom-ingenieur,* which is reserved by law for engineers thus academically trained.

On the whole, the mere academic study is put forward much further than under the English method, but it would be entirely wrong to assume that "academic" is synonymous with "abstractly theoretical." Strong emphasis must be put on the observation that the utmost importance is attached to exercises in actual construction and to the courses in the mechanical laboratories. These exercises are supervised by the best of the practicing engineers of the country. It is quite the rule for these professors not only to furnish opinions upon important industrial propositions, but themselves to devise, elaborate and detail them. Out of their drafting-rooms come often the most perfect workshop drawings, complete to the smallest detail. This close combination of theoretical instruction and practical work very naturally and constantly conforms technical instruction to the actual conditions of industrial engineering. The exercises given in constructive work differ scarcely at all from the employment the young engineer finds when he first enters the drafting-room of a large establishment. To make this educational scheme possible, the preliminary requisite is exact knowledge of the processes, requirements, and ideas of the workshops of the country. This may be the reason above all others why in Germany the workshop year must be taken before beginning with theoretical studies. Whether or not this educational order is correct is a matter of opinion. The report mentioned above says much in favor of it.

In the United States an attempt is being made to alternate practical work with the college studies. A certain equivalent of this idea appears in the holiday exercises in Germany. These serve also to demonstrate the increase in ability to grasp the essentials of matters of practice after each additional year of study. It may be asserted that a student during his workshop experience will see and learn as much in one day after his academic studies as he would in ten days before them.

The result thus demonstrated would suggest that the workshop year be taken after the studies. A further reason for this order is purely economical. The *volontairs* are of course a burden to the industrial works into which they are taken. Factories are designed to produce economically, not to serve as pedagogical institutions. The manager will give special attention only to those operations in his factory which mean a direct increase of dividends; therefore, the professional training of the *volontair* will be less intently looked after

the less the student knows and the less his productive value. Further, when the young man leaves the works at the end of the year, he goes to college for a four-year term, and it is highly improbable that after passing his examinations he will return to employ his talent in the same factory where he passed his student year. The chance, therefore, that the proprietor will even ultimately receive compensation for the attention and outlay he has spent upon the student is very remote. If, on the other hand, the practical training follows the academic instructions, as we find it in the United States, things are on quite a different footing. The great establishments in America or England which receive each year a certain number of engineering apprentices may well look upon them as most promising raw material. They aim to form these young men according to their special wants. So far as their *personnel* is concerned, the situation is like that, for instance, of an establishment producing its own specially-suited machine tools. Although the entire scheme for training engineering apprentices is often taken to be a highly philanthropic institution, we must not deceive ourselves by assuming that any but simply economical considerations underlie the plan. The fine club house which the Westinghouse Company has built for engineering apprentices will pay splendidly by the invaluable party spirit that arises here among the engineering staff, even from the very first days of their service. And though 50 per cent of the engineering apprentices might be released after their course is completed, we must not think that this is merely the expression of a *nobile officium* rendered by these large establishments—as if, perchance, there were a moral obligation for the strongest and richest corporations to provide the country with a useful rising generation of educated workmen. On the contrary, the other half which is kept every year is the choice, and the training of the rejected half was necessary to secure the numbers and standards of the selected class. Every owner of a racing stud knows that not every colt becomes a first-class runner, and he must keep a whole stock farm to breed some few exceptional horses. It would be utterly wrong to regard this cool and deliberate point of view as a fault of the English method, for the economical impulse is always the most intense, and the more intense the impulse the better the product.

The only serious disadvantage of this special training is that it may produce (and indeed it has already begun to produce) specialists whose excellent accomplishments in their particular branches are impaired by manifest ignorance in adjoining fields. Their lack of comprehensive viewpoint produces one of the greatest dangers threatening technical progress to-day—specialistic dogma.

The provision of workshop training as a precedent to the college course, without any particular view to any specialized future occupation, favors universality of perspective. On the other hand, the absence of an economic incentive tends to deteriorate training. In Germany, we try continuously to make up for this want, which many persons recognize clearly. We try to replace the economic incentive by an intensified moral incentive. The Society of German Machine Works (*Verein Deutscher Maschinenbauanstalten*) in Dusseldorf endeavors to put pressure upon its members to take up the effective training of *volontairs* more heartily than in the past. It is to be feared that this stimulus will not achieve the purpose. To secure really satisfactory results a considerable amount of time and money are indispensable. The immense organizations for the practical training of engineering students in England and in the United States show that clearly. Special personal attention could replace these institutions only to a limited degree. If an immediate economic advantage is not to be expected, expense and care will be devoted only by those who work with their whole heart and soul, and this spirit cannot be ingrafted into one who does not himself possess it. Considering this, the German technical colleges must be well content that they have at least succeeded in securing from five-hundred prominent German machine works assurances of willingness to take a limited number of young men as *volontairs* every year, upon payment by the student of an average sum of 300 to 500 marks, (£15 to £25, or $75 to $125) for the privilege.

Most workshops having done little for the *volontair* except granting admission, and the instruction given, if any, having been rather poor and entirely unsymmetrical, we have tried to remedy the faults in various ways. Excellent help is given in some cases by the official (and partially obligatory) apprentice continuation courses created by the well-known "social political legislature." The following programme of the continuation courses in one of the most prominent factories will show the high grade of instruction sometimes given by these schools. The annual programme of the most advanced class in Ludwig Loewe & Company's apprentice continuation school is as follows:

	Per week.
Political economy and instruction in constitutional rights and duties	1 hour
Bookkeeping, exchange, and common law	1 "
Algebra, logarithms, and slide-rule computations	1 "
Euclid, stereometry, and trigonometry	1 "
Metallurgy of iron	1 "
Workshop information	1 "

The subjects specified in the last-named course are of much interest. Systematic instruction is given concerning:

(1) Cutting tools; chasers, planers, drills, taps, reamers, milling cutters, backed-off cutters, files, scrapers.
(2) Clutching implements; hold-fasts, screws, vises, sockets.
(3) Measuring implements; rules, calipers, slide gauge, micrometer gauge, standard gauges, limit gauges.
(4) Tracing on the surface plate; ruler, surface plate, water level, bevel protractor.
(5) Mechanical cutting; turning, planing, milling, examining for faults, mandrels, centers.
(6) Machine elements; screws, belt pulleys, gear wheels, change gears.
(7) Reading of drawings.
(8) Hardening, tempering and grinding; tools, swages, punches.

Stress must be laid upon the fact that these courses are held for apprentices, not for the *volontairs,* so these latter may attend the lectures only as outsiders. This is only apparently a disadvantage; indeed, two great advantages are combined in this system. The first is social. The young man learns early to understand and to estimate the expenditure of energy which is involved in following mental training in addition to every-day work in the shop. The laborers like to see their future engineers sitting side by side with their young sons. Ludwig Loewe & Co. join with this a second advantage. The *volontairs* pay for this advanced education the sum of £50 a year. With a dozen of them usually admitted thus to the practical training in the factory, the company may recoup a good deal of the cost of the splendid education it gives to its apprentices. Thus, the *volontairs* are no longer a burden but a financial advantage to the works. I estimate this as the greatest achievement of the Ludwig Loewe system. It retains all the advantages of taking factory work in anticipation of college studies, and avoids all the disadvantages of postponing practical training until the last.

Unfortunately, this good example has so far remained without imitators. Evening courses, generally attended by very poor efficiency, are not always practicable, and seldom give the necessary material in a good instructional way, unless in the presence of specially talented or unusually well-trained teachers. Possibly a future form of the programme of the technical colleges will postpone the workshop year and substitute a first-class introductory college course.

There is today perhaps but one help applicable in all cases—a good and useful book written *"ad hoc."* There are such specially prepared books which the young *volontair* may study during the workshop year and which give him a better understanding of the leading ideas in the activity surrounding him.* It would indeed be a serious mistake to

* The author of this article has written such a book, which will shortly be published in English by Messrs. Constable & Co., the title being "The Workshop Year of the Mechanical Engineer."

consider that the workshop year is to be used only for the cultivation of a certain manual dexterity.

The many crafts associated in the building of a modern machine can not be learned by anybody in one or two years, however capable he may be, but a longer time than this can not be spent, at least in Germany. The young man there leaving college at about eighteen years of age must give a whole year to general military duties, four years to study in the mechanical college, and he must not be a charge on the paternal budget after twenty-five years of age. It seems, then, to be clear that the decisive criterion of practical training can not be sought in the learning of manual skill. It is clear, further, that the many attempts to replace practical work by college instruction shops will be abortive. Such shops do not reflect the life nor the conditions of a producing factory. The student of medicine can not learn to cure the sick by dissecting the dead; this can give only a certain exercise—nothing more.

The essential in the training of engineers is to make them understand that the demands of economy are the deciding conditions in technical construction and development. This perception can never be gained in a workshop secluded from current industrial life. Mere manual skill is of little use to the modern engineer, (though he may sometimes use it to advantage as, for example, when inspecting the erection of a machine) for we find that the most highly developed art of the modern constructor is expressed by the most extensive application of machinery in place of hand work. To teach this art, the English and American methods of training seem highly suitable. While this perception gains ground continually in Germany, the question of radical reform of the German system of practical training, to conform to the trans-Atlantic example, can not yet be discussed. It is extremely interesting to find that at a time when pure technical college instruction is so highly developed in Germany that England and America take it as a pattern, practical training is yet disproportionately neglected. On the other hand, this sort of training is brought to high perfection in some places in England and America. It therefore seems possible that Germany, in exchange for her technical methods, may receive from English-speaking nations methods for the best practical training of mechanical engineers.

THE PEAT RESOURCES OF THE UNITED STATES.*

By Charles A. Davis, Peat Expert, United States Geological Survey.

The exhaustion of America's fuel resources is recognized as a contingency near enough to cause anxiety, and protective measures have received a good deal of attention. As pointed out in our editorial columns this month, reforms, to be operative, must be constructive. That is, a bar across the road we want to close is not nearly so effective for that purpose as the opening of a better way as an alternative. Dr. Davis's demonstration of the profits derivable from the peat beds of the United States should act as a stimulus to their utilization, and thus automatically protect deposits of other fuels which it is desirable to conserve for special purposes that they alone can properly fulfil.—THE EDITORS.

IN the present generation, the attention of investors and the general public in the United States has but recently been turned to the possibility of using peat for fuel and as raw material for a number of manufacturing industries. This in spite of the fact that it is well-known that it has been used for very many years in northern Europe, where, as estimated by competent observers, approximately 10,000,000 tons of peat fuel prepared for market by various processes are consumed each year. Smaller quantities of peat are also prepared and sold for bedding for stock, for packing material, for sanitary purposes, and for making a number of manufactured products.

Economists, engineers, economic geologists, and others have taken the attitude that the United States had no need to use peat fuel because it was so amply endowed with wood and coal and so marvelously rich in its deposits of natural gas and mineral oils; and that, even if it were desirable to use it, peat could not be produced here with profit as a substitute for or auxiliary to any of them. The attention of the country, however, has been turned recently to the forcible statements of the National Conservation Commission, as well as to those of similar bodies in various States, that those fuel resources which from early times have been considered inexhaustible were already greatly depleted, and must be used less wastefully and less lavishly if the great prosperity of the country primarily based upon them was to be continued. Apparently the time has come when it is necessary to take account seriously of stock of all of the materials which may be used to augment or supplement the more commonly used fuels, in order that the future may be planned for and dealt with fairly.

* Published by permission of the Director, U. S. Geological Survey.

While the antagonistic or agnostic attitude noted above has been maintained by the majority of those by whom America should be guided in such matters, the utilization of low-grade fuels as sources of producer gas has made considerable progress in Europe, where the necessity for more economical ways of using raw materials has arisen sooner than in America. At a time when in America the use of coal at the mines for producing electric energy in quantities to be transmitted to distant centers of consumption is still a dream to be realized in the future, entirely trustworthy reports come from Sweden, Germany, and other countries of northern Europe that peat is actually being used successfully, in plants built at the bog, as a source of producer gas for use in internal-combustion engines to generate electricity for lighting, traction, and manufacturing purposes in towns miles away. Moreover, some of the plants which are so operated are built in units of 150 horse power and develop less than 500 horse power for the entire plant, thus refuting the idea that such installations must be only for large units and great total current production. Such reports have of necessity created considerable interest in the minds of those in the United States who have kept in touch with developments of this sort, and have stirred to renewed activity those who have seen the possibilities of using peat as a supplementary fuel.

In 1905, some preliminary tests of peat were made at the St. Louis testing plant of the U. S. Geological Survey in a large pressure gas-producer; while too few in number to be of value for drawing general conclusions, they were highly satisfactory and as far as they went verify the reports of European success with peat for gas production. These early experiments have been confirmed by one made during the present year at Pittsburg in a different type of gas producer, that was quite as satisfactory as the first ones. It may be safely assumed from these tests that some peats of American origin are but little inferior to many grades of bituminous coal now finding ready sale, and above some in the number of cubic feet of producer gas which they will yield for a given weight, and in the calorific value of the gas. It should also be pointed out that these tests show that a ton of peat, used in the gas producer, will develop more power than an equal weight of the best coal to be obtained, used under a steam boiler. It is evident that fuel of this character should not be ignored entirely.

Attention has also been called by reports from abroad to uses of peat producer gas other than for gas engines; these state that it has been used with success in metallurgical operations, as in foundries and steel works, and in brick and glass making, as well as in various ceramic kilns.

The modifications of the Mond process and type of gas producers which have recently been worked out by the investigation of Frank and Caro in Germany, to adapt them to the use of peat for fuel, have opened up still more attractive possibilities for utilizing this substance. By this modified process, the greater part of the combined nitrogen of peat may be converted into ammonia and recovered as ammonium sulphate during the process of gasifying the peat in large gas producers. As nitrogen is present in American peats in large percentage relative to that of Europe, some showing more than 3 per cent of the dry peat, and as it has been shown by the experimental work of the inventors of this process that peat with but little more than 1 per cent of weight would yield enough ammonium sulphate to pay for running the plant, for its maintenance, for gasifying the peat, and leave a profit besides, while a large part of the gas was left as additional profit, it seems worth while to consider whether or not in the near future peat beds of proper character may not be exploited with profit as sources of power and ammonium compounds in the United States.

The Frank and Caro process has the advantage over others in being able to use peat with from 40 to 50 per cent of water, thus obviating many of the difficulties experienced in drying the material before it is used. The successful operation of plants of this type recovering ammonium sulphate requires large and expensive installations, however, and this seems to be its chief disadvantage although several fully equipped plants are said to be in process of erection in various parts of Europe.

Since peat used in the gas producer near or at the bog from which it is dug requires no transportation of any consequence, it would be unnecessary to give it other than the simplest preparation for storage, which would permit of properly drying it. For the same reason, peat with high ash content, which it would not pay to transport, could be used for producer gas—a fact that should be considered when large areas of peat of this character occur near manufacturing centers.

Peat utilization appears more certain as a future probability when it is known that those parts of the country possessing extensive peat deposits that may be considered of commercial importance, are located along the northern boundary and in the coastal plain of the Atlantic region. Other, but more limited, areas occur in the western mountains and in the damper parts of the States bordering the Pacific. The States with the largest areas of peaty land are the eastern Dakotas, Minnesota, Wisconsin, Michigan, northern Iowa, Illinois, Indiana, Ohio, the whole of New York, New England, New Jersey, and

a part of Pennsylvania; the coastal portions of Virginia, North and South Carolina, and nearly all of Florida. It is also exceedingly probable that there are workable peat beds in the swamps of the Gulf States and in the parts of the flood plain of the Mississippi and its tributaries lying at a distance from the streams. These regions of the frequent occurrence of peat, as will be seen by a glance at the map, lie almost entirely outside of the coal fields, with the exception of Michigan, where, as is well known, but a small part of the coal basin has yet been found productive—most of the workable coal seams being apparently quite closely confined to the vicinity of Saginaw Bay.

In making comparisons between peat and coal, it should be taken into account that peat can be mined and prepared for the gas producer, the furnace, or any other use, by very simple and low-price plant, and with much less danger than is attendant upon other forms of mining, as all of the workings are open cuts made by ordinary excavating or dredging machinery, or, as in Europe, by the use of a specialized form of spade, so that practically all the dangers and discomforts of underground mining and the expense of equipment needed for it are avoided. The fact must not be overlooked, however, that the great obstacle in the preparation of peat for fuel, or other purposes, has always been and continues to be the fact that it contains from 85 to 90 or more per cent of water as it lies in the beds. It has been demonstrated beyond any possibility of doubt that this water cannot be quickly and cheaply removed by pressure below about 70 per cent, and centrifugal machines are equally ineffective in removing it, so that it must be removed by evaporation. It may also be shown by a simple calculation that not enough heat units can be obtained from the dry residue obtained by artificially drying a ton of peat as dug, to evaporate the water from another ton; hence it is apparent artificial drying cannot be resorted to, but that the slow and generally uncertain air drying must be used, except where large supplies of waste heat are available. Air-dried peat has a moisture content of from 15 to 25 per cent, and its theoretical fuel efficiency is lowered by the water in about direct proportion to the amount which it contains. As noted above, however, it seems quite possible to use peat with at least 40 per cent moisture in recently developed types of gas producers, and drying to this percentage may be cheaply accomplished by plowing or digging up the surface of the peat and allowing it to be dried out by the wind and sun as it lies on the bog from which it has been dug. Peat taken from below the water level in Florida, macerated in a pug mill, and then spread out on the ground in a layer 8 inches thick, dried in the air, even in the winter time, to an air-dried

condition in about three weeks, and would be ready for the gas producer in considerably less time.

While artificial drying of peat for fuel is impracticable, as pointed out in a previous section, it has received and is now engaging the attention of many able engineers and inventors who still hope to "solve the problem" which, in the opinion of many, must be worked out to a satisfactory conclusion before any large development of the use of peat for ordinary fuel purposes can be expected. To state this problem in concrete terms:—it is to find a method of handling the wet peat as it comes from the bog, containing about 90 per cent of water, so rapidly and cheaply that the approximately 250 pounds of salable material obtained in the air-dried state will pay, not only the cost of digging and preparation, but of management, amortization, and selling, and in addition will return a profit on the original capital. In another form, the problem is to dry out 1,800 pounds of water from 2,000 pounds of wet peat in such a way that costs may be met and a dividend declared from the 200 pounds of dry matter obtained, each pound of which will evaporate about 6 pounds of water from and at 212 degrees F., in a boiler. The answer is quite plainly apparent.

Note may be made of the fact that if peat with 90 per cent of water has its moisture content reduced to 80 per cent, the loss in weight of water is more than one-half, and this reduction may readily be accomplished by drainage, or by simple and cheap processes.

Peat is made into fuel in the European countries, where it is used in a number of ways primarily designed to make it less bulky and more easily transported than it is in the ancient form of cut peat, as well as to increase its efficiency as a source of energy. As cut peat it has extensive use in stoves for cooking and heating, in the form of air-dried blocks or sods, cut from the bog by hand labor with special forms of spades. A more compact and efficient fuel is made by more or less thoroughly macerating the freshly dug wet peat and pressing it into moulds, after which it is allowed to drain and dry by spreading the blocks on the ground exposed to sun and wind. A somewhat more modern method of preparation is to grind it in a specially designed pug mill similar to the pattern commonly used in grinding clay for brick making. The peat is ground wet as it comes from the bog, and is delivered from the mill in the form of wet bricks, which on exposure to the air and the heat of the sun for a comparatively short time become dry, firm, tough, and, compared with untreated peat, non-absorbent. This is "machine" peat of the European markets, and it seems to be the most generally successful and commercially important form of peat fuel for domestic and boiler use to be

found in them. It is also the type now used in the gas-producer plants. This product has from 20 to 25 per cent of moisture as it is sold, with a theoretical value of about 65 per cent of the same weight of good bituminous coal, if used as domestic fuel or for steam production. It is probable, however, that its practical efficiency is somewhat greater than indicated by comparison of heat units per pound, if burned in properly designed and regulated fireboxes, with the right sort of grates, because there is practically no waste from peat in the form of volatile carbon, clinkers, and cinders, and no corrosion from sulphur, while the ash, though bulky, is generally light and powdery.

The material when pressed into briquettes is more compact, and thus more transportable, burns more slowly and persistently, and stands transportation and handling well. Its fuel value per pound is not much increased by briquetting, unless it is heated sufficiently to drive off some of the more volatile matters and thus increase the proportion of carbon. Peat to be briquetted properly must be dried carefully, pulverized, and pressed in an efficient and rapid briquetting press. A binder may be used, and in Europe coal and lignite dust have been mixed with the peat before briquetting.

Peat charcoal and peat coke are being manufactured in considerable and apparently increasing quantities in Germany and Russia, where these products are used as substitutes for wood charcoal in iron manufacture and in other metallurgical processes, including copper refining and steel making, for which its freedom from sulphur and phosphorus renders it valuable.

No process of peat-coke production has so far proved profitable, when undertaken in commercial plants, except such as recover a series of by-products by condensing the gaseous products of the destructive distillation of the peat. These by-products are practically identical with those obtained by the destructive distillation of wood, where charcoal is made in retorts or in properly constructed kilns—namely, fuel gases, methyl alcohol, acetic acid and acetates, ammonium salts, tar, and its derivatives. This sort of by-product recovery, however, requires large preliminary investment for equipment and the keeping up of an expensive and short-lived plant; but if a good market exists for the output, experience seems to show that the outlay is profitable in the United States in the case of charcoal production from wood. Trustworthy and unbiased reports from Europe indicate that this type of utilization of peat is on a satisfactory basis, where it has been tried. The preparation of peat for coking is identical with that where it is to be sold as machine pressed peat for fuel, and after drying, it is stored in open sheds until needed for the coking retorts.

Peat powder is being used in increasing quantities in blast burners for firing under boilers, and in brick, glass, and cement production. When the powder is properly prepared and the firing is rightly controlled, the peat becomes nearly as efficient as gas when burned in this way.

Gas production from peat has passed beyond the experimental stages in several European countries, as has been noted above. Peat gas is said to be used for illuminating purposes in a few localities, but it is as producer gas that it reaches its most important deveiopment. Among its applications are boiler firing, metallurgical operations, burning lime and brick, and in glass making, but its most noticeable and rapidly increasing use is in internal-combustion engines installed in connection with producers located at bogs for generating electric power for transmission to cities. It may be of interest to note that one plant of the sort just mentioned, of about 300 horse power, is located on a bog of some 35 acres superficial area, and an average depth of 5 feet. The life of this plant is estimated at 30 years, and the quantity of fuel available at 44,500 tons. In the northern United States there are hundreds of such bogs now lying waste, while fuel is being drawn from far distant coal mines to supply them with light, heat, and power.

In view of all of these facts, the following estimates of the peat resources of the United States have been prepared with a view of at least calling attention to the very considerable source of wealth to the nation which is now lying entirely undeveloped in the swamps and bogs of the country.

In taking account of the possibilities of the peat beds, it will be noted that they furnish potential substitutes for wood in various departments of industry, and in these ways may relieve in some considerable degree the drain upon our vanishing forests. The estimates given I believe to be conservative in every respect, and in no case has optimism been consciously allowed to tinge the possibilities with too rosy a color.

The following sources of information have been used in the preparation of the estimates: Publications, and topographic and other maps, of the United States Geological Survey, reports of the State Geological Surveys of New York, Michigan, Iowa, Indiana, New Jersey and Massachusetts; co-operative reconnaissance peat surveys undertaken jointly by the United States Geological Survey and the State Surveys of Connecticut, Maine, and Wisconsin; unpublished data collected by the United States Geological Survey, and personal observations collected in various parts of the country by the writer.

The total swamp area of the United States, exclusive of Alaska, is estimated * to be..... 139,855 square miles
Of this, 8 per cent is assumed to have peat beds of good quality, or ..... 11,188 square miles
The depth of peat over this area is assumed to average at least 9 feet, giving 200 tons of dry fuel per acre for each foot in depth, or a total of..... 12,888,500,000 tons
Value if converted into machine peat bricks at $3 per ton. $38,665,700,000

VALUE IF COKED AND THE BY-PRODUCTS OF DISTILLATION SAVED.

	Product in tons.		Value.
Peat coke	3,608,800,000	(Charcoal price)	$26,005,300,000
		(Coke prices)	9,743,700,000
Illuminating oils	257,800,000		4,474,200,000
Lubricating oils	90,200,000		
Paraffin wax	38,700,000		3,479,900,000
Phenol	167,500,000		66,345,100,000
Asphalt	25,800,000		824,900,000
Wood alcohol	43,800,000		7,844,000,000
Acetic acid	56,700,000		.....
Ammonium sulphate	39,900,000		2,777,400,000
Combustible gases	738,400,000		6,501,300,000

Peat coke, in the better grades, has a very low sulphur and phosphorus content and may be substituted in any use whatever for hardwood charcoal. The amount of wood which would have to be used to make charcoal equal in amount to the quantity of peat coke given in the estimate would be approximately 8,019,800,000 cords. While this material was being coked, there would be given off from the retorts an indeterminate quantity of uncondensable gases, which have good fuel value, the maximum being about 300 B.t.u. per cubic foot; these can be used successfully for heating the retorts, drying, and for power, so that the process of coking would be practically self-sustaining.

If converted into producer gas by the most recent methods, with the recovery of ammonium sulphate, there would be possibly available 619,257,511,000,000 cubic feet of producer gas, having a calorific value of 145 B.t.u. per cubic foot.

Assuming 1.5 per cent of nitrogen as an average amount in American peat (which is low, since numbers of analyses show more than 3 per cent) each ton of dry peat run through the gas producer would yield 100 pounds of ammonium sulphate. On this basis, there is enough stored up nitrogen in the estimated quantity of peat to give at least 644,400,000 tons of ammonium sulphate, which may be valued at $36,732,400,000, in addition to the value of the gas obtainable.

The European tests which have been made under rigid test conditions show that from 2 to 2.5 pounds of peat will develop an effective horse power per hour if gasified in a properly designed gas producer and used in an efficient gas engine. If the larger amount is taken for the sake of conservatism, it is apparent that there is stored

* 60th Cong. 1st Sess., Sen. Doc. 151.

up in the estimated peat deposits of the United States energy enough to develop some 10,310,860,800,000 effective horse-power hours.

Great quantities of the more fibrous kinds of peat are made into litter for bedding live stock, in Europe, and into peat mull, or powder, for absorbent and sanitary uses. It is estimated that at least 2,578,000,000 tons of this kind of peat is available, and as it is superior to straw and other substances now commonly used for the purpose, and would readily bring a higher price, it is here valued at $10 per ton, or the whole amount has a prospective value of $25,780,000,000. Some thousands of tons of this material are annually imported from Europe to the coast cities of the United States, and there is a single factory located in Indiana now putting it upon the market, which sells its entire output of several hundred tons at about $12 per ton.

A single plant for paper-making, using peat fibre, has been in operation in Michigan. Possibly 5 per cent of the total amount of the peat of the country is suitable for paper stock, or 644,400,000 tons. The use of this material would decrease proportionately the consumption of wood and straw for the manufacture of wrapping and other coarse papers and pasteboard. In most of the present processes for making paper from peat fibre, a certain percentage of wood pulp or rags is introduced to strengthen the product.

Peat is being quite extensively used in the United States for fertilizer filler. It is especially used in making various grades of artificial fertilizers in which slaughter-house and other refuse animal matters with a considerable amount of available combined nitrogen are ingredients, or in which hygroscopic inorganic compounds are used. The peat is dried and pulverized and in this form is especially adapted to the purpose, since it absorbs water and ammonia greedily, is antiseptic and an effective deodorizer, and prevents fermentation and chemical decomposition better than any other substance ever used in a similar way. At the prices now paid in the open market for peat prepared for fertilizer filler, and assuming that one-half of the entire estimated amount of peat is suitable for the product, its value is estimated to be at least $38,666,000,000, or about the same as that of the entire quantity for common fuel purposes.

Ethyl or grain alcohol has been made from certain moss and other poorly decomposed types of peat in Denmark and Sweden, at a cost estimated at about 47 cents per gallon. At this price it would hardly be available for power production in gas engines of the explosive type, since, for this purpose denatured alcohol has about the same value as gasolene in energy developed, per unit of volume, as shown by the tests made at the fuel-testing plant of the United States Geo-

logical Survey at the Jamestown Exposition. If, however, 10 per cent of the entire body of peat of the country could be used to manufacture ethyl alcohol, about 70,900,000 tons of the product could be made. It should be noted that the processes mentioned do not yet seem to have reached a commercial stage of development.

A slow-burning, or nearly fire-proof, mixture of peat and mineral cements has been made in a small way under the name of artificial wood. It has been formed into paving bricks, boards, and various units for structural purposes, as a substitute for wood and other material in buildings. About 10 per cent of the peat resources estimated above may be adapted for making this or similar compounds, or 1,288,800,000 tons, the use of which would make available an equivalent amount of sawed lumber or permit it to be held in reserve.

Thoroughly cleansed fibrous peat is reported to be finding a steadily increasing use in Europe as packing material for breakable or perishable articles, and for protecting and insulating water and other pipes which are likely to be frozen up in winter. The peat best adapted to such use is too light in weight and too loose in texture to be made into fuel, and probably occurs in the bogs of the country to the amount of 500,000,000 tons, which should have a market value of at least $3,000,000,000—displacing excelsior, hay, straw, paper, sawdust, and other similar materials now in use.

Fabrics of considerable variety, mattresses for hospitals, fiber for surgical, absorbent, and other aseptic and antiseptic dressings, and substitutes for, or adulterants of, other fine fibers for use in making cloth, have been made from certain grades of peat; but the market is so well supplied with other materials for the same purpose, which are as good or better, that the use of the peat products has never reached any extensive commercial scale.

It seems clearly apparent from the foregoing discussion that in the peat beds of the United States, there is now lying practically untouched a vast quantity of carbonaceous matter from which there may be obtained by intelligent, properly considered, and conservative exploitation, fuel, power, fertilizing substances of the highest value, and raw material from which may be manufactured a considerable number of salable products—all of which will serve to supplement and therefore extend the life of the other resources which are now clearly shown to be limited in quantity. The wealth of the Nation will also be possibly increased by the large sums which represent the potential cash value of the peat beds, if these resources are properly utilized, while at the same time an equivalent amount of other useful and valuable material will be set free to be used for other purposes.

THE GAS POWER PLANT AS A MEANS OF FUEL CONSERVATION.

By Dr. Charles E. Lucke.

The following discussion was prepared and delivered as introductory to a lecture by Dr. Lucke before the Society of Arts, at the Massachusetts Institute of Technology. The rest of the lecture was concerned with a simplified explanation of the operation of the gas power plant and the principles underlying its high economy. This preface affords so admirable a review of the fundamental physical process by means of which power is generated in internal-combustion engines, and so sound an estimate of the possibilities and limits of the gas engine as a conserver of fuel supply, that we have sought and obtained the opportunity to give it here a wider circulation and the opportunity of a larger influence.—THE EDITORS.

AT no time in the history of the country has there been so keen and so general an appreciation of the importance of conserving natural resources, among the greatest of which, in point of value and universal use, is the fuel supply. Any movement that has for its object the saving of fuel without loss of useful effect should receive the support of every good citizen. One of the greatest drafts on our coal beds is made for power service, so that any effort toward better fuel economy in power generation will result in a very material extension of the time the available supply may be expected to last. It is because the gas power plant has demonstrated beyond question its inherent ability to do the same work with less fuel than is possible with steam plants, that it must be placed among the beneficent inventions. By this system of power generation not only can the power fuel supply of the country be made to go from one and one-half to six times as far as it would with continuance of our present methods, but poor qualities of lignites and peat, now practically useless, will be made available for power purposes. The apparatus by means of which such enormously important results are being worked operates on principles not at all complicated in themselves, but often so intermingled as to be difficult of recognition. My belief that some knowledge of the simpler and more basic of these principles would be of interest to every educated person has led me to attempt this discussion.

In the operation of the factories of the United States at the time of the last census, 1900, there was required about eleven and one-third million horse power, of which, roughly, 77 per cent was steam.

15 per cent water power, and less than 2 per cent gas power. The average size of each engine was only about 67 horse power. Taking into account (in addition to factories) the power plants of street railways and public-service central stations, as well as all power used in mining and quarrying industries, there was reported about seventeen million (17,000,000), horse power, of which fourteen million (14,000,000) was steam, the average size of each unit being quite small in comparison with the maximum. If the average coal consumption per hour per horse power for the steam plants were placed at the small figure of 3 pounds, the best being 1½ pounds and a common high value 5 pounds, then the coal consumption per hour for the 14,000,000 steam horse power of the above industries would involve the consumption of 42,000,000 pounds, or 2,100 tons of coal per hour. The actual hourly consumption of coal for these engines is considerably less than this, because all these units will not be at work all the time, nor will they operate at maximum power even when in operation; and the uncertainty of these factors makes it quite difficult to arrive at a figure of the actual rate of consumption of power coal. Of the amount burned for the steam power, however, the gas power plant can save a very considerable part, the saving depending on the size of units, the nature of the work they are doing, the kind of coal they are burning, and a variety of other things. There is often heard the claim that the substitution of gas power for steam should be made at once because it would result in the doing of two and one-half times as much work, or that at the present rate of consumption gas power plants could make our power-coal supply last two and one-half times as long. Such sweeping statements are based on incomplete comprehension of the conditions and facts and could be made only by thoughtless enthusiasts. While the steam-plant coal consumption per hour per horse power ranges from 1½ pounds in large, highly refined steam plants to perhaps 5 pounds in smaller and simpler ones, the corresponding values for gas plants will range from a little over 1 to a little over 2 pounds, so that the saving of the gas plant over coal would depend on the size and types of each used in the comparison. The average size of plant in the above named industries is small enough, being between 100 horse power and 200 horse power, and of such type as to warrant an estimate of a two-fold coal saving provided substitution could be made. This cannot be done as yet, because in the first place the bulk of the coal used is of such kind as the gas power plant has not yet been adapted to use, and because in the second place the gas plant has not yet been adapted to

the service in all cases, and because thirdly there are certain financial reasons why the substitution is not warranted.

Although it is true that the gas power plant has not yet developed far enough to invade all the field occupied by these steam plants, yet it is sufficiently perfected and adapted to some of them and the available fuels in the particular locality to warrant immediate substitution; and in proportion as it is substituted, and in proportion, at the same time, as it becomes adapted to more and more different varieties of fuel, so will it be capable of saving more and more of our enormous coal consumption for power purposes. There is no doubt, therefore, that it is at present a great factor in coal conservation and will become more and more potent as necessity for conservation becomes more acute.

The substitution of gas power for steam power, no matter what the fuel may be, is not going to be brought about by any principles of philanthropy. It would be folly to suppose that any factory manager would change his steam plant into a gas power plant just because he was anxious to save the national coal supply; nor is it likely the coal companies, who earn in proportion to sales, can be expected to help much. Any manager who made such a change for such a reason would be unfit for his position, unless as a consequence of that change he could show an improvement in his expense account or an increased profit to his particular employer. It is mainly, therefore, on the cost basis that the motive for the saving of our great fuel supply by such means as the gas power plant offers, must be founded. That a saving in coal does not necessarily involve a reduction of the cost of power is a well-known proposition to power engineers, but it does seem to be new to some conservation enthusiasts. Whenever a saving of coal consumption involves a change from cheap to a more expensive coal, there might easily be a financial loss; or when the change involves the abandonment of a cheap coal for an expensive gas or oil, there might reasonably be expected a loss. When the change involves the adoption of an engine that cannot be relied upon there will certainly be a loss due to interruption of the service; when the new engine costs more to maintain than the old, a saving in coal may not be sufficient to offset the difference in repairs; when the gas power plant costs very much more than the steam power plant to buy, the interest on the difference between the investments may more than offset a saving in coal. In many ways, then, it may be true that a saving in coal does not mean a reduction of cost of power, and therefore does not appeal to the purpose of the purchaser of coal for

power. Not until the purchaser of coal for power purposes can be made to see that the use of a gas power plant, with its lower fuel consumption than the steam plant, will also involve a net gain in the cost of generating power—not until then, can the power user be expected to contribute and use this means of conserving our national fuel supply.

It is a fact that while in all cases gas power plants can be made to generate power for less fuel than steam plants of the same size, this saving in fuel is in some cases accompanied by a saving in power cost and is, therefore, a profitable thing to do, while in other cases it is not. The differences of conditions that produce the different results are chiefly those of size of plant and kind of fuel supply. The gas power plant is not yet completely adapted, although rapidly becoming so, to all kinds of fuel, and many of the most popular kinds of coal, notably of the bituminous sort, are still giving the producer trouble; so that it frequently happens that substitution of gas power for steam power would involve a change from bituminous to anthracite coal or coke, both of which are well adapted to the older form of producer; the time is not far distant, however, when this will not be the case and producers will be available for every fuel. Perhaps the more potent factor is size. The steam power plant is so much more economical of fuel in large sizes than in small, and the gas power plant so constantly economical in all sizes, that the difference between them is small in large plants and large in small plants. It would appear on analysis that by reason of certain other conditions, previously mentioned, in large power plants at the present time burning coal fuel, steam is still cheaper than the gas system, although more wasteful of coal. On the contrary, in small power plants of the size representing the average in use in factories, for example (which is 67 horse power as reported by the census) the gas power plant is able to save so much coal that it can produce power at very much less total cost than the steam power plant, and can give quite as satisfactory service if the proper fuel is available. The cost of producing power in these small gas power plants in the neighborhood of 100 horse power, provided they use the same fuel, will be just about the same, and as low as can be secured in our largest and best steam central stations that have taken a great many years to develop. In order that this statement may be more definite I will offer the following figures, recently computed by me for a 75 horse-power gas producer and engine plant burning small anthracite coal at $4.00

per ton of 2,000 pounds—a high price—and operating at full load half the time.

75 Horse Power Plant. Division of Power Costs.

	Cost per horse-power hour, in cents.	Per cent of total.
Fixed charges on investment of engine, producer, electrical generator, switchboard, foundations, building, piping, etc.	0.364	28.1
Repairs and Maintenance	0.046	3.6
Labor	0.474	36.7
Miscellaneous	0.046	3.6
Coal	0.253	20.0
Lubricants	0.106	8.0
	1.289	100.0

These figures are based on one of the most expensive types of plants with very liberal labor allowance, so that with less attendance and cheaper machines the total cost would come under one cent for the life of the plant which, of course, would be less than for the better built machines. While it is true that these costs will be affected by changes in any one of a score of items, it is quite certain that in small sizes the gas power plant can be shown to be a paying proposition over steam, except where it is to stand idle for much of the time, and where coal is very cheap, as at the mines; and it is by study of such figures that the substitution of steam can be brought about with consequent fuel conservation.

A comprehensive study of every phase of the problem, engineering and economic, scientific and commercial, will lead to the conclusion that as the gas power plant becomes more and more adapted to the various fuels and to the various kinds of service to which engines are put, it will be more than anything else the great fuel-supply conservation means, and therefore, entitled to consideration, respect, and encouragement by the public in general. On such grounds everybody may properly be expected to understand to at least some degree the principles of operation, the application of which is to bring about this nationally important economic result.

EDITORIAL COMMENT

Practical Conservation Doctrine.

CONSERVATION, whether of materials, of energy, or of human effort, is rapidly becoming more significant as an economic issue and is receiving more and more attention in public discussions and legislative acts. Especially is this the case in the United States. The wastefulness provoked by the impatience of a new civilization and the overabundance of natural wealth, begins to give place to something of the same wisdom of thrift that has long characterized the older and poorer countries of the Continent. But conservation measures are effective only when they can be made to appear advantageous financially to existing interests, or when new propositions can be advanced that offer larger possibilities of profit than the old order. For example, the wood-alcohol industry was never disturbed by representations of its destructiveness, its ruinous effect on present and future values of woodlands, and its menace to water powers. The manufacturers were affected in no way that they could see by these things; the profits came onto their books, and the losses fell elsewhere. Only the introduction of denatured alcohol operated to save the dwindling forests from the further ravages of the acid factory.

Practical conservation, then, is that which not merely denounces the waste, but persuades to the saving. When this is accomplished, reform becomes automatic. It is hard to induce people at large to deny themselves for the sake of future centuries, or even generations; but no one has to argue long with us to make us seize an evident, present, and large advantage to ourselves.

For promotion of this practical conservation, our current issue is interestingly rich in suggestions. Dr. Lucke, Dr. Davis, and Prof. Hollis, on different planes and by different avenues, advance toward practical results in one of the most important problems of conservation —the conservation of fuel; most important, because it lies at the foundation of our material civilization, which is essentially a civilization dependent on the use of power, and fuel is still our great power source. The low-pressure turbine and the gas engine represent agencies that are immediately available; peat utilization is a long step beyond, but the step holds much of interest, and when it is made on a path joining that of progress with the gas engine and the gas producer, it may lead us in a doubly rapid advance toward better economy in the employment of our resources.

Idleness and Inefficiency.

THE introduction of the tariff bill into Congress, and the strong urgency for its early passage, hold out hope that the United States may soon rise from the relapse into industrial inefficiency which has now continued for eighteen months. Inactivity, such as now exists, is none the less inefficient because it is enforced and inevitable. The inefficiency is that due to fractional load and undiminished (or little diminished) "stand-by losses." Expenses necessarily run on while profits are cut off. The deplorable thing is that in a very little while the now unused, and hence forever lost, capacity of the idle plants will be sadly regretted and hopelessly longed for in a period of overload. It is a pity, indeed, that we can not yet realize Mr. Emerson's ideal state of national efficiency, outlined in our March issue, in which some department of the social organization (be it Gov-

ernment, or an organization outside of Government) will furnish a flywheel—a regulator — a storage — by which the overproduction possible in periods like the present can be safely taken up and strongly held, to be released again when the peak of the demand rises. Then the curve of our activities will show nearly a smooth line instead of its present alternating dizzy heights and sickening depressions.

The Inefficiency of Dishonesty.

THE ideal of organized National efficiency may be far off. Any one who reads the history of the world and measures progress carefully, must hold with large reservation any hope that the people will soon be all very wise or all highly honest. But only a pessimist could deny that we are making progress away from the inefficiencies of dishonesty. We may not expect that the Hughes Commission will make Wall Street altogether the abode of sweetness and light, but yet we must admit that a rapid and considerable change is taking place in American canons of business morality. There are reactions and reversions to the slime of the earlier period, still, but they are fewer and farther between. Such a project, for instance, as the Dominion Copper "reorganization" which by its plausible auspices would sometime ago have passed unchallenged, now arrests indignant attention and protest. Even an inchoate and despised minority takes heart from the spirit of awakened business morality and asserts its claim to honest treatment. And their movement is recognized as both a civic service and a utilitarian one —the promise of rescue of a valuable property, so that it may serve the purpose of supplying the world with its hitherto undeveloped resources instead of being merely an excuse for the manipulations of a coterie of "high financiers."

The gospel of efficiency, like every other gospel that has ever been preached, condemns dishonesty; but it goes further than preaching, and shows that the penalty for the sin of inefficiency does not depend on any outer judgment that may be evaded, but follows as inevitably as burning follows the handling of fire.

Returning to Normal.

THE new Administration has already spread a feeling of stability and confidence rather remarkably definite in view of the short time and limited opportunity offered; and with the introduction of the new tariff measure, the greatest uncertainty heretofore discouraging business revival is brought to the edge of removal. It is true that weeks or months may elapse before the bill is passed, and that the final schedules may be very different from those brought in by the Ways and Means Committee. But it is at least certain that on all great items influencing construction or manufacture to any important extent, the Payne bill suggests the maximum of change to which future undertakings must be adapted. Any modifications will be toward the past normal, not further from it. And "knowing the worst," business can adjust itself in a measure to the prospect. Probably it will progressively discount the future and assume increasing activity without waiting actual passage of the bill. Already there are signs of revival, not as a general movement, but beginning (as the decline began) by scattered instances, here and there, and increasing in numbers and importance.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE LOCK CANAL FOR PANAMA.

A SUMMARY OF THE REPORT OF THE ADVISORY BOARD OF ENGINEERS.

Engineering News.

THE report of the Advisory Board of engineers who accompanied President Taft on his recent visit to the Panama Canal works, transmitted to Congress by Mr. Roosevelt on February 17, should dispose for all time of the much disputed question as to the feasibility of the lock canal plan now being carried out. While the most specific commission of the Board was to investigate the safety of the Gatun dam, their report deals in a general way with the condition of all parts of the work, and a considerable part of it is devoted to a discussion of the merits of the sea-level canal project which has recently been agitated with renewed vigor. The Board's endorsement of the lock-canal plan is unanimous and emphatic and the eminence of the engineers composing it leaves no doubt that the discussion has at last reached an authoritative and conclusive settlement. We take from the full report as published in *Engineering News* for February 25 the following abstract of its more important sections.

Especial consideration was given by the Board to the foundations for the Gatun dam and the feasibility of constructing thereon a safe dam for retaining water at 85 feet above sea level. Investigation of the records of the experiments which have been made and examination of the materials in the open cuts and those disclosed by test borings have satisfied them that there will be no dangerous or objectionable seepage through the materials under the base of the dam, nor are these materials so soft as to be liable to be pushed aside by the weight of the dam to an extent sufficient to cause dangerous settlement.

The combination rock-fill and hydraulic-fill type of dam now under construction has the unanimous approval of the Board. The exterior faces are to be composed of rock of all sizes obtained from the canal excavation, dumped and laid on slopes much flatter than are ordinarily found in earth dams, while the interior of the great mass will consist of clayey material obtained by hydraulic dredging from large deposits at a little distance from the dam site. The most practical question in the construction of the dam is the possible slipping and sliding of the materials underneath and in the body of the dam. They are, for the most part, of a clayey nature, impervious to water, but liable to slipping when subjected to heavy unbalanced pressure or when deposited on high, steep slopes. To be stable and permanent, a dam built of these clayey materials must have slopes flatter than would be necessary to secure the stability of a dam built of silicious or gravelly materials. In the opinion of the Board, the data which have been accumulated by experiment as to the degrees of slope that are stable with the materials available prove conclusively the possibility of building of them an absolutely safe and permanent structure; they report, indeed, that "the design upon which the work is now being prosecuted abundantly fulfils the re-

quired degree of stability, and goes far beyond the limits of what would be regarded as sufficient and safe in any less important structure." Such slips as have occurred have been caused wholly by piling up material, as a matter of convenience and economy during construction, on slopes much steeper than are contemplated in the finished work; they are without serious consequences either in the execution of the work or in the ultimate stability of the dam.

The Board consider the dam as designed to be not only unnecessarily strong but also unnecessarily high. The crest, they say, may safely be lowered 20 feet from the elevation originally proposed, that is, to an elevation of 115 feet above sea level, or 30 feet above the normal level of the water against the dam. They report also that the sheet steel piling proposed for the base of the dam may safely be omitted.

Considerable space is given in the report to the changes which have been made in the plans since the project was adopted in 1905. One of the most important of these is the moving of the lower locks on the Pacific end of the canal from La Boca to Miraflores, about four miles inland. The controlling reason for the change was a military one. The cost of the work will be increased about $10,000,000 thereby, but this will be offset to a large extent by a reduction in the cost of fortification.

The increase in the minimum bottom width of the canal (from 200 to 300 feet) for about 4.7 miles in the Culebra cut will add about $13,000,000 to the cost. The change will not delay the completion of the work and the increased width will in many ways facilitate navigation through the canal. Other changes of importance, all of them justified, according to the report, although adding considerably to the cost of the canal, include the increase in the dimensions of the locks from 95 by 900 feet to 110 by 1,000 feet, the relocation of the Panama Railroad, and the modification of the plans of the harbor works at either end of the canal.

The Board see no reason why the work should not be completed, as estimated by Col. Goethals, by January 1, 1915; in fact, they consider an earlier completion of the work quite probable. They also approve Col. Goethals' estimate of $360,000,000 as the total cost of the canal. The cost as estimated in 1905, exclusive of the cost of sanitation and Zone government and the payments to Panama and the French Company, was $140,000,000. Including present estimates of the items then excluded, the total estimate would have been $217,000,000. About half the difference of $143,000,000 between this amount and the present estimate is accounted for by the changes made in the plans; the remainder is to be attributed mainly to the higher unit costs of the different items of the work than those used in the 1905 estimates, due, the report says, in part to the higher prices for plant, supplies and labor which have prevailed in the United States since the estimate of 1905 was made.

From the Board's discussion of the relative merits of the sea-level and lock types of canal we quote at length: "In view of the fact that the cost of the lock canal as now proposed will largely overrun the estimate of the minority of the Board of Consulting Engineers of 1905, and that the excavation in the Culebra cut is being made somewhat more rapidly than was anticipated, we have considered in a very general way the relative cost and time of construction of a sea-level canal.

"Most of the factors which have operated to increase the cost of the lock canal would operate with similar effect to increase the cost of the sea-level canal, and at the present time there are additional factors of even greater importance to be considered as affecting the time of completion and cost of a sea-level canal. One of these is to be found in the Gamboa dam, proposed to be nearly 200 feet in height above its foundations, which would be about 60 feet below the normal river level. Prior to the construction of this dam a long and deep diversion channel must be provided of far greater magnitude than that for the Gatun dam, which has been about two years in progress, and is not yet completed.

"Judging by the time required for the

construction of dams of similar magnitude in the United States, it is probable that were work on the Gamboa dam to be started as soon as possible, this one feature of the sea-level project of the Board of Consulting Engineers of 1905 could not be completed until after the time required for the completion of the lock canal. The construction of this dam at Gamboa for the control of the Chagres is an essential preliminary to the excavation of the sea-level canal for the thirteen miles from Bohio to Bas Obispo. Furthermore, in addition to the Gamboa dam, the sea-level project provides for building for the control of tributary streams three large dams, the sites of which have not been examined.

"Work is already far advanced on nearly all parts of the lock canal, and a change in the type would result in abandoning work done which represents large expenditure.

"Under the plan now being carried out, the River Chagres and each of the other rivers on the Isthmus tributary thereto is made an ally of the project. The waters of these rivers are handled economically and in such a way as to facilitate the operation of the canal. With the sea-level project, these rivers instead of being allies would be enemies of the canal, and floods in them would greatly interfere with the work.

"The excavation of the canal would be carried to 40 feet or more below sea level and to a much greater depth below the bottoms of the valley in which the upper streams now flow.

"It would further be necessary to cut long and large diversion channels on each side of the canal, for streams entering the Chagres Valley. The cost of such lateral channels to protect the Culebra cut alone from the comparatively small streams formerly entering it, including work done by the French, has probably been not less than $2,000,000. The channels required for the lower valley of the Chagres would be much longer, larger and far more expensive.

"It has been suggested that the canal region is liable to earthquake shocks and that a sea-level canal would be less subject to injury by earthquakes than a lock canal. We have seen, in the City of Panama, the ruins of an old church, said to have been destroyed by fire, containing a long and extremely flat arch of great age, which convinces us that there has been no earthquake shock on the Isthmus during the 150 years, more or less, that this structure has been in existence, that would have injured the work proposed. Dams and locks are structures of great stability and little subject to damage by earthquake shocks. The successful resistance of dams and reservoirs supplying San Francisco with water, even when those structures were located near the line of fault of the earthquake, gives confidence in the ability of well designed masonry structures and earth embankments to resist earthquake shocks.

"We do not regard such shocks as a source of serious damage to any type of canal at the Isthmus, but if they were so, their effect upon the dams, locks and regulating works proposed for the sea-level canal would be much the same as upon similar structures of the lock canal. The Gamboa dam for controlling the floods of the Chagres in connection with the sea-level canal provides for a lake having an area of 29 square miles when full, and if this water were suddenly let loose into the sea-level canal it would seriously injure large portions thereof and wreck ships therein. A similar result would be reached if the other three dams of the sea-level canal retaining lakes, having an aggregate area of ten square miles, were to be destroyed.

"We believe that the sufficiency of the water supply for a lock canal has never been seriously questioned. It is true that during the dry season the natural flow of the streams would not be sufficient to furnish the water required for numerous lockages. There would even be times when the natural flow would not suffice to make good the loss by evaporation from the surface of the water in Gatun lake. During the rainy season there is a great excess of water which can be readily stored in Gatun Lake, with its area of 163 square miles. It is proposed to fill this lake during the rainy season 2 feet above its normal level, and to draw it as needed during the dry season. It is computed that by drawing it 5 feet

below normal level, which draft would leave 40 feet of water through Culebra cut, the supply in a dry year would be sufficient to serve from 30 to 40 lockages up, and an equal number of lockages down, daily. Each lockage might consist of a single large vessel, or a fleet of smaller vessels, capable of being in the lock at one time, as is common at Sault Ste. Marie. For comparison the published record shows that an average of only twelve ships per day passed through the Suez Canal in 1907.

"From our examinations in the neighborhood of the Gatun dam, we can find no reason to apprehend important loss of water by seepage through the ridges surrounding the lake, while in our judgment the bed of the lake will be practically impervious to water. The water supply in sight is so much greater than any need that can be reasonably anticipated that the problem of securing more water when the time of need arrives does not require to be considered now.

"In conclusion, your Board is satisfied that the dams and locks, the lock gates, and all other engineering structures involved in the lock canal project are feasible and safe, and that they can be depended upon to perform with certainty their respective functions. We do not find any occasion for changing the type of canal that has been adopted. A change to a sea-level plan at the present time would add greatly to the cost and time of construction, without compensating advantages, either in capacity of canal or safety of navigation, and hence would be a public misfortune."

THE COMMERCIAL PROSPECTS OF THE PANAMA CANAL.

A GENERAL DISCUSSION OF POSSIBLE SOURCES AND VOLUMES OF TRAFFIC AND OF PROBABLE REVENUE

G. A. Ballard—The Contemporary Review.

IN comparison with the political and strategic aspects of the Panama Canal, the commercial prospects of the undertaking have received very little public discussion. It is true enough that a detailed forecast of the commercial future of the canal is as yet impracticable; but a general anticipation of its prospects which should be broadly accurate may be obtained by working upon the basis of existing conditions, and the almost inevitable operation of certain economic laws. Such a study is made by Mr. G. A. Ballard in *The Contemporary Review* for December, 1908. His discussion is based on a minimum total estimate of £38,000,000 as the cost of a canal of the lock type As pointed out on another page of this issue the best estimates now available place the cost of the completed canal at $360,000,000, about double the amount which forms the basis of Mr. Ballard's calculations. This discrepancy, however, does not lessen the validity of his arguments or the interest of his conclusions, of which we give a brief summary below.

It may be taken for granted that the canal revenue, whether raised to defray working expenses or to furnish a dividend, will be derived from some system of dues levied on the tonnage passing through. The traffic must therefore bear a sufficient relationship to the extent of the undertaking if the canal is to be a financial success. Mr. Ballard endeavors to place the whole enterprise in its most favorable light by basing his estimate on the minimum estimates for cost of construction and cost of operation and maintenance and on the highest reasonable figure for volume of traffic. We have already mentioned his estimate of first cost; he takes £1,000,000 per annum as the lowest possible figure for working expenses. To cover the latter, therefore, and in addition pay a 4 per cent. dividend, the traffic must yield dues amounting to rather more than £2,500,000 per annum, which represents the very lowest at which the canal will prove moderately profitable.

Is this sum likely to be forthcoming? A paying volume of traffic on any new thoroughfare can arise only from the diversion of previously existing traffic from other routes through the offer of a cheaper or in some other way more ad-

vantageous line of transit, or from the generation of entirely new traffic on an adequate scale, or from a combination of both, as in the case of the Suez Canal. It is a comparatively easy matter to arrive at a fair idea as to what existing lines of traffic are likely to be abandoned in favor of the Panama route. Existing commerce follows certain clearly defined lines imposed by the physical geography of the globe, from which it can in general only be diverted by offering artificially shortened and, therefore, usually cheaper routes. But it is important to remember that the shorter is not invariably the cheaper. When two routes of equal length are open to choice, one of which is free and the other subject to toll, all traffic will naturally follow the former, and if a route which is taxed is only slightly shorter than a rival which is not, the dues charged must be light or they will drive the traffic to the latter. The scale of dues must in fact be proportionate to the benefits conferred, and that is a matter requiring nice adjustment to give the best returns. The great advantage enjoyed by the Suez Canal is that the alternative route by sea to the eastward is so much longer that heavy dues may be imposed with impunity. At the present rate of 7 fr. 75c. per ton the total sum paid by an ordinary steamer would be enough to purchase coal for an extra week or ten days steaming, but even that would not cover the extra distance.

Another matter which affects the choice of routes, and here again the Suez Canal is exceptionally favored, is the spacing of fuel stations along alternative lines. If there is any considerable gap it means that extra fuel must be carried to cover it, which beyond a certain point can only be done by encroaching on the cargo space. Yet another consideration affecting the selection of a route is the opportunity it may give of trading at intermediate points.

With these four considerations as a guide, relative shortness of distance, freedom from charges, convenience of fuel stations, and opportunities for trading, it is not difficult to foresee which of the old routes will be deserted in favor of the Panama Canal. It is self-evident in the first place that only those three routes which have one terminus in the Atlantic or its immediately adjoining waterspaces, such as the Mediterranean or the North Sea, and the other outside can be affected. The most important of these, the Suez Canal route, the main avenue of intercourse between the East and the West, will be little affected by the Panama Canal if the four considerations mentioned above continue to apply in the future as they have in the past. In the matter of dues it may be expected to compare favorably with rivals always, for the dividends it now earns, something like 20 per cent., leave ample margin for reductions in the event of a war of rates. Reference to a chart will show that for European traffic the whole Asiatic coast will remain more easily accessible by the old way than by the new. The existing trade from American Atlantic ports to destinations east of Hongkong will find the Panama route somewhat shorter, but to points west of Hongkong the distance will remain in favor of the old route. The total volume of this trade, however, is so small that the diversion of a fraction will hardly affect the Suez Canal, and furnish but little business for Panama. Its present tendency is to decline.

For the Australian branch of the Suez traffic, the advantage of distance is with the old route to the extent of about 2,000 miles in the voyage from Europe to Melbourne, and 1,200 in the voyage from Europe to Sydney. Here, however, the turning point is reached and New Zealand may be considered within the natural sphere of business of the Panama route. The difference in distance is not great but enough to divert the traffic if the dues are not too heavy and a properly equipped fuel station is made available somewhere in the Tahiti Archipelago. With good business management the bulk of the direct traffic between Europe and New Zealand, now worth about £25,000,000 per annum, should be attracted to Panama and furnish a respectable addition to the receipts.

Next in importance to the Suez route is the alternative route to the East around the Cape of Good Hope, partly to African and partly to Asiatic or Aus-

tralian ports. The ships bound for African ports obviously can have no use for the Panama route. Neither will the canal appeal to the remainder which pass on into the Indian Ocean, partly the diminishing remnant of the once great sailing fleet in the Asiatic trade, and partly steamers following the longer route in preference to the Suez route because employed in conveying freight to ports of call on the way.

The third route in order of importance and the one most likely to be affected by the opening of the canal is that which leaves the Atlantic by the Straits of Magellan and passes around Cape Horn. The diversion of trade from this route constitutes the chief commercial hope of the canal. According to the best available statistics, the average annual value of the trade between Atlantic and South Pacific ports amounts to about £20,000,000. A considerable part of this will probably pass by Panama but not all. There is a point on the Chilean coast at which the distances by the old and the new routes will be equal, and vessels seeking or leaving ports in the vicinity of this point will avoid the canal to escape paying dues. It is probable however, since this point is some distance south of the chief commercial centres of Chile, that the greater part, probably at least £16,000,000, of the South Pacific trade will use the Panama Canal. The trade with the North Pacific is carried on mainly in sailing vessels, owing to the competition of the railways. The canal, however, will so shorten and cheapen the voyage that steam traffic will become profitable and all trade or nearly all will follow the new route in consequence. The annual value of this trade is about £30,000,000, which, added to the others already assessed would give a grand total of £70,000,000 a year, as representing the existing value of the branches of sea-borne traffic which may be expected to turn to the new route when ready. By 1920 this amount may possibly have doubled, judging from the present rate of increase, and £150,000,000 annually may be taken as a liberal allowance of the "business in sight."

This volume of traffic, about two-thirds of that passing through the Suez Canal, at Suez rates would return about £3,000,000 annually. But it is probable that not more than an average rate of two-thirds of the Suez scale will be tolerated by traffic diverted from other routes, which would give about £2,000,000 per annum. At least half of this must go to meet working expenses, leaving one million available for dividends on a capital cost of thirty-eight, or little more than 2½ per cent. It is evident that the canal cannot hope to prove a commercially profitable undertaking until the trade has risen to something like treble its present value according to Mr. Ballard's estimate, or six times its present value according to the latest estimates of the cost of the work.

The question of newly created trade is a much more difficult one. The matter resolves itself into an investigation as to whether, in the first place, any of the requirements of countries or markets brought nearer to each other by the canal will be producible on one side, and, by using the canal, more cheaply deliverable on the other than from rival sources of supply; and, secondly, as to whether in cases where existing sources threaten to fail in satisfying future demands in full, the new route will enable the deficit to be made good from fresh areas of production. Speaking in very general terms, it may be said that an investigation of the first part of the question leads to an answer in the negative, and of the second to an answer in the affirmative. There are no requirements of the Atlantic markets which cannot be supplied from sources nearer at hand than the Pacific Coast of America, whether the canal is constructed or not, but it is open to question whether these nearby sources will remain permanently equal to the demand. If nearer sources of supply reach their limits of output the North American Pacific may be trusted to contribute its quota of foodstuffs and raw materials to Atlantic markets; and conversely the development of the Pacific coasts following upon an expansion of their exports would stimulate the demand for manufactured goods from Atlantic industrial centres. To what figures it will ultimately rise it is difficult to say but it cannot be expected in the

near future to rise to a point where the tonnage passing through the Panama Canal would yield dues sufficient to bring the annual revenue up to 4 per cent. of the cost of construction, even according to Mr. Ballard's estimate. This would require the transit of a tonnage conveying £75,000,000 worth of goods.

The conclusion is inevitable, therefore, that the canal cannot prove a commercial undertaking during its early years even at a most liberal computation, but the fact that it does not seem likely to pay a good dividend for some years does not necessarily mean that it never will. Its future will be dependent on the growth of population in certain regions, but no man can foretell with any confidence the direction the question of population may take. The most that can be asserted now is that the increase which will be required to furnish the canal with paying traffic is not likely to be reached in the near future and may never be reached at all. The very fact that it is unlikely to prove a commercial success, however, should only serve to enhance the credit due to the political foresight which recognises that its value to the promoters in other directions justifies the expenditure even when there is small hope of a financial return.

A PROCESS OF MAKING GAS FROM OIL.

A DESCRIPTION OF A METHOD AND APPARATUS FOR THE UTILIZATION OF RESIDUUM OIL.

Walter C. Willard—The Iron Trade Review.

A RECENT development in the gas power field, which offers a striking illustration of the applicability of the gas producer and gas engine to the utilization of low-grade, and even of otherwise worthless, fuels, mentioned by Dr. Lucke on another page of this number, is a process for making gas from residuum oil, hitherto a waste product. It is claimed for this process that the gas can be produced at a cost of from 12½ to 24 cents per 1,000 cubic feet, and in especially favorable localities at a cost of 7 cents per 1,000 cubic feet. A description of the methods and apparatus is given by Mr. Walter C. Willard in *The Iron Trade Review* for February 11, from which the following extracts are taken.

"The process consists essentially in mixng oil with air and vaporizing and gasifying the mixture, resulting in a perfectly fixed, colorless gas of from 700 to 1,220 B.t.u. per cubic foot, and a candle power from 10 to 20 according to the conditions and grades of oil used. It is claimed that there is positively no deposit left in any part of the apparatus, except a small percentage of tar which falls in the settling tank. No ash and no free carbon or coke can be found.

"The gas when burned in an ordinary mantle burner burns with no smoke and gives a clear white light from the mantle. It can be used wherever natural gas can, for lighting, heating, or power. When burned in an open gas heater, the flame is a clear blue with no perceptible traces of smoke. When used in an internal-combustion engine it is claimed that it burns perfectly clean, leaving no tar or acid formations which might be detrimental to the working of the engine." The maximum cost in any part of the country, for gas of 700 B.t.u. per cubic foot, is said to be 25 cents per 1,000 cubic feet. The process is extremely simple and perfect results can be obtained with very little attendance.

"The operation is roughly this: an air and fuel mixing nozzle is made to deliver a mixture into an iron burner, where it is heated and thus gasified, and led out through small holes in the burner where combustion takes place. This burner supplies the heat necessary to vaporize the oil fed to the retorts in which the gas is made. One nozzle, like that used in the burner, furnishes a mixture of oil and air to each pair of retorts. One burner furnishes sufficient heat to operate eight pairs of these retorts."

The burner is placed in a fire box below the retorts which are arranged vertically in pairs. Oil enters the lower retort of each pair at the bottom and gas is led from the upper to settling tanks whence it is piped to a storage tank. The

size of a 10-retort apparatus is 5 feet wide, 4 feet deep and 7 feet high over all; the capacity of a plant of this size is conservatively estimated at 2,000 cubic feet per hour, using four gallons of fuel oil per 1,000 cubic feet, including the amount used in the burner. The average cost of residuum oil used is about 2½ cents per gallon; practically its only other use is for sprinkling roads. It is also claimed that either crude oil or some of the lighter distillates may be used.

"The application of this process is practically universal, since special burners may be built to operate directly under a steam boiler. It is only necessary to remove the gate bars, set in the burner on the supports, and fill in with loose fire brick. By this means the heat is spread to cover as large an area as desired and no one point is appreciably hotter than any other. This overcomes one of the greatest drawbacks to the use of oil for fuel according to former practice. Heretofore it has been a problem to dissipate the heat and still maintain perfect combustion. With this system, if the oil and drafts are properly adjusted, there is practically no flame visible, simply a steady heat making all within the fire box show up at practically one color. No stack is required, simply a flue to carry off the products of combustion." It is said that a temperature of 2,900 degrees F. can be maintained. Careful tests have shown that by using a special burner it is possible to evaporate from 17 to 20 pounds of water per pound of fuel oil used. In one instance an evaporation of 23.82 pounds is reported. A test made under rather unfavorable conditions gave an evaporation of 15.82 pounds of water per pound of oil as against 9,442 pounds per pound of Kanawha coal in the same boiler. At this rate one gallon of oil will evaporate 115.8 pounds of water and 162.7 gallons of oil would be equal to a ton of this coal.

The following is a typical analysis of the gas produced:

	Per cent.
Hydrocarbon vapors	15.55
Carbon dioxide	1.70
Heavy hydrocarbon	1.05
Oxygen	0.20
Carbon monoxide	2.60
Methane	23.04
Hydrogen	2.90
Nitrogen	52.96

STRIKE INSURANCE IN FRANCE.

THE ORGANIZATION OF ONE OF THE LARGEST MUTUAL ASSOCIATIONS.

Engineering.

WE have referred several times in these columns to the socialistic tendencies of contemporary social and industrial legislation in France and to the deplorable condition into which French industries are rapidly being forced by the pernicious activities of socialist and labor leaders. There is a class of men in the country, among whom may be found the secretaries of trade unions and sometimes even members of Parliament, whose chief occupation is to foment strikes, and under present conditions labor disputes and their consequences are fraught with much more danger to employers in France than in any other country. As a consequence of recent strikes, some works have had to close down, because they were unable either to fight or to accept the conditions demanded of them by labor, and from some employers concessions have been extorted which constitute a grave danger to the satisfactory progress of French industry. The situation has become so acute that the employers of labor have been forced to form mutual benefit associations for insurance against strikes. The organization of one of the most important of these, covering the metallurgical industry, is described in the following extracts from an editorial review in *Engineering* for January 29.

"In 1906 the employers' syndicate of engineering, boiler-making, and moulding works took into consideration the advisability of forming an organization against strike risks. This led to a federation which comprises a series of mutual insurance primary companies and secondary funds. The first group, corresponding to a particular industry, embraces mechanical and electrical works.

A distinct mutual insurance company was formed covering the manufacturers of railway carriages and wagons. The 'Forge' fund was then formed, the largest company of all, and which includes both rolling mills and steel works. Then followed that which covers structural works, and afterwards a fund covering the foundries.

"The insurance company, which comprises the various metallurgical works' owners of the Ardennes, in the North-East of France, is a separate institution. Other similar insurance companies were formed at various intervals, and simultaneously also the 'Caisse Centrale Métallurgique,' the object of which is to insure the primary insurance companies, and as a consequence the works' owners, against a possible insufficiency of resources at the disposal of the various primary insurance companies.

"The primary insurance companies work as follows:— Each one is formed of works' owners whose outputs are of a similar nature, this insuring a community of interest among all the members. Each member has also to form part of a commercial syndicate approved by the insurance company which he wishes to join, the syndicate on its side having to be connected to the Union des Industries Métallurgiques et Minières, formed in France with a view to bring together the works' owners whose line of activity lies in metallurgy and mining. Each primary company is constituted for a period of thirty years; this period can be extended, and each member enters upon an engagement to form part of the insurance company during the whole life of the latter; but each member—and the insurance company has the same facility—can sever its connection at the expiration of every period of five years by giving six months' notice. The contract between each member and the company ceases at any time should the former close his works finally. If a works is sold, or the proprietary is modified, the insurance company may close the contract with the owner of that particular works, seeing that the insurance is a private agreement.

"The object of the insurance company is to guarantee all members against part of the pecuniary losses resulting from partial or total cessation of work in their establishments following a dispute between the management and the *personnel,* also against the proceedings instituted against them by the *personnel* on the occasion of such a dispute. The indemnity the insured member receives constitutes practically a compensation for the general charges which he continues to bear, notwithstanding a partial or a total stoppage of his works. He has to make known the difficulty in which he is by reason of a strike at the earliest possible moment, and at least six days after cessation of work, his declaration being made direct to the Central Committee, which decides whether the dispute does or does not give right to an indemnity. The Central Committee was formed outside of every mutual insurance company, with a view to complete impartiality. The committee in question is an offshoot of the 'Union des Industries Métallurgiques et Minières,' but is a completely independent institution. It consists of six members, appointed for three years by the 'Union,' a third of the members being renewable every year; its opinions and decisions are valid only when given, or arrived at, by four members at least. All decisions which would have for their effect to exclude from the receipt of an indemnity have to be arrived at by a majority of two-thirds of the members present.

"The duties of this Committee are most important. In order that the benefits resulting from the insurance be fully allowed, it is necessary that a conflict should have been 'suffered, followed up, and concluded in accord with the Committee.' A works' owner does not lose his liberty of action by the fact that he is insured; but if he should take decisions, or follow measures which the committee disapproves of, he loses his right to an indemnity. It is, in fact, a declaration on the part of the Committee that there is full agreement between it and the insured member, which compels the fund of the insurance company to pay an indemnity in the conditions and proportion contracted for. No difficulty is experienced in the matter. The Committee is regularly informed by the own-

er as to the conditions in which a strike has occurred, on its causes, and the possibility of a settlement; the Committee gives the owner judiciary advice, while endeavoring at the same time to protect the general interests of industry, and bearing in mind legitimate claims on the part of the men and legitimate resistance on the part of the employer. The Committee can hand over to the employer the certificate enabling the latter to receive the indemnity, even should he not have complied with all the advice tendered by the committee, if the latter considers that while declining this advice the employer has had regard for equity, and for the general welfare of industry. Something, therefore, as will be seen, is left to appreciation, as is the case in a judgment rendered by a Court of Law.

"The extent to which an employer is covered by the insurance company corresponds to the general charges on the employer's works. These include rent, fixed salaries, contracts for light, heat, power, water, telephone, etc., annuities on patents, and like expenses, but not interest on capital or on debentures or the proportion of profits set aside for a sinking fund. The total of such charges cannot be enlarged for insurance purposes. An evaluation is made at the time of signing the policy of insurance. It is not allowed to limit the amount covered by insurance to less than 50 per cent. of the general charges. The basis on which an insurance is taken out can be revised every year. The evaluation of the losses caused by a strike is arrived at by an expert agent appointed by the insurance company, who acts in conjunction with the insured member or the latter's expert agent; should the two not agree, they select an umpire.

"The principle upon which the insurance is based is mutuality, but responsibility is clearly limited. Every insured member, even in the worst circumstances, can only be called upon to the extent of 3 per cent. on the amount insured by him individually. It was deemed unnecessary to demand at once the total of the premium, each member being only asked to pay a sufficient amount to cover the indemnities likely to be required in the course of a year, and the premium paid is in every case limited normally to the payment of 1½ per cent. on the amount insured. This forms the provident fund, and the rate of 1½ per cent. is that which has been paid since the formation of the insurance companies. No call has been made to form what has been styled 'the guarantee fund.'

"The secondary, or federative fund, whose title is 'Caisse Centrale Métallurgique,' acts as a mutual insurance fund towards the separate insurance companies. Its organization is the same as that of the latter, with the difference that its members are those companies and not individuals. It guarantees the primary insurance companies against any insufficiency in their resources should these be absorbed entirely by strikes in the course of the year; that is to say, the sums paid in to the extent of the maximum premium of 3 per cent.

"The operations and risks of the Caisse Centrale Métallurgique extend over a wide area, and are numerous, seeing that it re-insures insurances which cover a large number of different industries. Its relations with the primary insurance companies are practically the same as those between the latter and their members. It is administered by a council elected from the administrators of those primary companies who have insured a minimum of 20,000*l*. Should the sources available with the Caisse Centrale become insufficient to indemnify completely all the primary companies insured, a proportional distribution of the sums would take place.

"The combination works with complete success. In April, 1907, the general charges insured by the various mutual insurance companies, and re-insured therefore by the Caisse Centrale, did not reach a total of 3 million francs (120,000*l*. At that date the organization was new, and many people did not believe it would be attended with good results, or were of opinion that the premiums would have to be very high to cover all the risks. In the middle of 1907 the general charges insured rose to 15½ million francs (620,000*l*.); at the present time the sum insured exceeds 21 million francs (840,000*l*.). The premium has never exceeded 1½ per cent."

TEMPERATURE DISTRIBUTION IN THE GAS ENGINE.

THE RESULTS OF RESEARCHES ON ITS RELATION TO THE CONDITIONS OF WORKING.

Bertram Hopkinson—Institution of Civil Engineers.

TWO of Prof. Bertram Hopkinson's contributions to the literature of the gas engine have already been reviewed at some length in these columns. His first paper on the efficiency of the gas engine, read before the Institution of Mechanical Engineers in October, 1907, was reviewed in THE ENGINEERING MAGAZINE for January, 1908; an abstract of his second paper, dealing with the influence on efficiency of mixture strength and scavenging, followed in the July number. His latest investigations have been directed towards the determination of the actual temperature distribution in the gas engine cylinder and its relation to the conditions of working. We give below a brief summary of the results communicated to the Institution of Civil Engineers on February 2.

In the course of the expansion and exhaust strokes of the gas-engine, from a quarter to a half of the whole heat developed in the explosion is discharged into the cylinder-walls. This flow of heat, though its effect on efficiency is relatively small, is very important in the practical working of the motor, because it necessitates the provision of special appliances for its removal from the outside of the engine as fast as it is generated within, and it also requires the existence of a temperature-gradient sufficient to carry it from the place where it is generated to the place where it is removed. In consequence, high temperatures must exist in the uncooled parts of the engine and great temperature differences between one part and another. These conditions give rise to dangers from pre-ignition, and also to large mechanical stresses in the metal, which, between them, account for a large part of the practical difficulties encountered in running large gas-engines.

Given the rate of heat-flow into every portion of the cylinder per square foot, it would be possible by a sufficiently elaborate mathematical analysis to calculate the distribution of temperature throughout the metal. Apart from the difficulty of the mathematical problem, however, the data for its solution are only imperfectly known, and a rough calculation of the general mean temperature distribution is all that is possible. Such a calculation made by Prof. Hopkinson leads to the conclusion that the temperature on the inner surface of portions of the engine which are efficiently water-cooled, such as the liner, can never rise above quite a moderate value. But the temperature at the centre of an uncooled piston, 12 inches in diameter, may reach 400 degrees C. or more. It also appears that the temperature at the centre of such a piston will vary as the square of the diameter if the thickness be kept constant, or directly as the diameter if the thickness be increased in proportion.

Prof. Hopkinson describes experiments made upon a Crossley gas-engine of 40 brake horse power, with the object of determining the actual temperature distribution and its relation to the conditions of working. The temperatures were measured by means of thermo-couples inserted into the piston-face and into the centres of the valves.

In the first group of tests these temperatures were compared with the total heat-loss as measured by the rise of temperature of the jacket-water. According to theory, the excess of the temperature at any point over the mean temperature of the jacket-water should be proportional to the total heat-loss, except in so far as the distribution of that loss over the metal surface exposed to the hot gas is altered. By varying the strength of mixture, keeping other conditions the same, the heat-loss was varied between limits of about 1,300 and 2,200 British thermal units per minute, the engine firing practically every time; and it was found that the piston temperature was very closely proportional to the heat-loss. In the exhaust-valve there was some deviation, the causes of which Prof. Hopkinson discusses. Under normal working conditions at full load the

temperature at the centre of the piston was found to be about 370 degrees C. above that of the jacket-water; in the exhaust-valve, 400 degrees C.; and in the inlet-valve, 250 degrees C.

From a comparison of the temperatures at different points in the piston-face and the temperature at the centre, the rate of heat-flow into the face of the piston is deduced, and found to amount to about one-eighth of the total flow into the engine. This agrees well, having regard to the difference of piston temperature, with the results obtained by Prof. Burstall, who measured separately the heat given to a water-cooled piston. It is a considerably smaller proportion than would be expected, and the reasons for this are discussed by Prof. Hopkinson. It is suggested that an important cause is to be found in the fact that the gas near to the piston is the last to be ignited in the course of the passage of the flame through the combustion-space, and is therefore cooler than the average in accordance with a principle established by Prof. Hopkinson some years ago.

Of the fall of temperature between the centre of the piston and the jacket-water, about one-half, or say, 180 degrees C., is between the centre and edge of the piston-face. In consequence of this inequality of temperature there is a considerable hoop tension at the edge of the piston-face. The magnitude of this is investigated, and it is shown that it probably amounts to several tons per square inch. It is pointed out that uncooled pistons of large diameter will be likely to fail by a radial crack at the edge which, in many cases, may be followed by seizing of the piston on account of the sudden expansion which is thus permitted.

The next group of experiments relates to the effect of varying the conditions of running upon the metal temperature. The dependence of heat-flow and temperature upon strength of mixture, time of ignition, and degree of compression are investigated.

(1) Strength of Mixture.—It appears that if the gas charge be increased by 30 per cent., the total heat-loss will be increased by 50 per cent. with a corresponding increase in the temperatures of the piston and inlet-valve.

(2) Time of Ignition.—Retarding the ignition by 20 degrees, the gas charge and other circumstances remaining the same, reduces the total heat loss by 10 per cent. The piston and inlet-valve are 20 per cent. cooler, these parts receiving a much less share of the heat than before. On the other hand the exhaust-valve receives a greater share of heat than with normal ignition, and its temperature is not materially altered. The thermal efficiency is reduced from 34½ per cent. to 28½ per cent.

Advancing the ignition by 10 per cent. has but little effect upon efficiency. It causes an increase of about 10 per cent. in the heat-loss. There is a more than proportional increase in the temperature of the piston and inlet-valve. The exhaust-valve is again but little altered.

(3) Degrees of Compression.—Comparative trials were made in which the engine was run first in the ordinary way and second with the half-compression cam, which is used for starting purposes, kept in action. The result in the latter case is that about two-fifths of the charge of gas and air is expelled unburnt to exhaust. In fact, the only thing changed is the density of the charge, all other circumstances remaining practically the same. It was found that heat-loss was reduced nearly but not quite in proportion to density, with a corresponding reduction in the temperatures of all parts of the engine. The effect of degree of compression upon efficiency and upon the practical working of the motor is discussed in the light of these observations.

Another set of experiments consisted of comparative trials with the engine running on half-load, so that every other cycle was a scavenging cycle, and firing every time, the circumstances being otherwise the same. It was found that the quantity of heat removed by the air passing through the engine in the scavenging strokes was insignificant in proportion to the whole.

Finally, a large number of experiments were made on the phenomena of pre-ignition. In order to cause the engine to pre-ignite, an iron bolt carrying

a thermo-couple at its end was introduced into the combustion-chamber. The end of this bolt was heated by the explosions, and it was found that it could be heated in this way up to a temperature of about 700 degrees C. without affecting in any way the working of the engine, but that if the temperature exceeded 730 degrees C. ignitions would take place from the end of the bolt. The effect of these ignitions is to heat the end of the bolt up more rapidly than before; they thus tend to propagate themselves, and to become more frequent, and if once they start the engine is bound to pull up. It was found that the line of division between the conditions under which safe and continuous running was possible, and those under which the engine was bound to pull up, was very narrow, and can be represented by an increase in the gas charge of only 1 per cent. This instability is due to the fact that the gas near the point of ignition of an explosive mixture is heated to a temperature much above the mean by the rise of pressure which follows its ignition. Thus the fact that ignition takes place through the bolt tends of itself to make the bolt hotter, and so to cause earlier and more frequent ignitions from the bolt.

THE TRANSMISSION OF POWER BY LEATHER BELTING.

A COMPREHENSIVE THEORETICAL TREATMENT OF THE WHOLE BELTING PROBLEM.

Carl G. Barth—American Society of Mechanical Engineers.

IN a paper read before the American Society of Mechanical Engineers on January 11 and published in the *Journal* for January, Mr. Carl G. Barth presents a complete theory of the transmission of power by leather belting which combines the results of his own investigations and experience during the past eighteen years and of the experiments of other members of the Society who have investigated different factors of the belting problem. The paper is a very comprehensive and valuable presentation of a subject which has hitherto been in a more or less uncertain state. In the following brief abstract we have attempted to indicate in a general way the main features of Mr. Barth's discussion and to give the more important of his formulae, but to obtain an adequate appreciation of their significance the paper itself must be consulted.

Mr. Barth first establishes a mathematical formula for the relation between the tension in a belt and the stretch due to the tension, based on experiments made at different times by Lewis and Bancroft, Bird and himself. He gives as a safe average formula on which to build an improved theory of belting.

$$L_t = L\left[1 + \frac{\sqrt{t}}{864}\right]$$

in which L_t equals the length of a belt under the unit tension t when its slack length is L.

By means of the knowledge of the elastic properties of leather belting expressed in this formula he develops a formula for the relations between the tensions in the two strands of a belt transmitting power, taking account of the influence of sag in a horizontal belt. This formula is

$$\sqrt{t_1} + \sqrt{t_2} = 2\sqrt{t_0} + 0.04c^2\left[\frac{1}{t_1^2} + \frac{1}{t_2^2} - \frac{2}{t_0^2}\right]$$

in which t_1 = the tension in the tight strand or side in pounds per square inch of belt section;

t_2 = the tension in the slack strand or side;

t_0 = initial tension used in tightening the belt;

and c = center distance of pulleys in inches.

For very short belts the last term in this equation, which is only tentatively solvable, becomes very small as compared with the term $2\sqrt{t_0}$. By neglecting it, the formula for vertical and short horizontal belts, or even approximately for all belts, may be written simply

$$\sqrt{t_1} + \sqrt{t_2} = 2\sqrt{t_0}$$

This formula may be enunciated as a new theorem of the relations of the

tensions in a belt, thus: "Under any variation of the effective pull of a belt, the sum of the square roots of the tensions in the two strands remain constant" as against the old fallacious supposition that the sum of these tensions remains constant.

The longer equation given above, however, may be made solvable with respect to t_1 by assuming that $t_1 = t_0^2/t_2$, which experiment shows to be an average relation of the tensions. The formula when rearranged after substituting this value of t_1 in the last term becomes

$$t_1 = \left[2\sqrt{t_0} - \sqrt{t_2} + 0.04 c^{\Phi a}\left(\frac{t_2^2}{t_0^4} + \frac{1}{t_2^2} - \frac{2}{t_0^2}\right)\right]^2$$

Mr. Barth has devoted a great deal of study to the question what coefficient of friction should be assumed in calculating the pulling power of a belt at any given speed. He has assumed a variable coefficient of friction expressed by

$$\Phi = 0.54 - \frac{140}{500 + V}$$

in which V is the velocity of the belt in feet per minute. From this formula and another is derived the expression

$$v = \frac{160 + 0.88\,V}{85 + 0.03\,V}$$

as the velocity of sliding on each pulley in terms of the velocity of the belt itself.

As the percentage of slip, x, between the circumferential speeds of the two pulleys of a belt is twice the percentage of the average total velocity of sliding v of the belt over each pulley, the expression for the percentage of slip corresponding to the coefficient of friction given above becomes

$$x = \frac{200}{V}\left(\frac{160 + 0.88\,V}{85 \times 0.03\,V}\right)$$

This whole theory of the variation of the coefficient of friction with the belt speeds rests entirely on the formula

$$\text{Ratio of Effective Tensions} = \frac{t_1 - t_c}{t_2 - t_c} = e^{\Phi a}$$

where t_c is the loss in effective tension due to centrifugal force per square inch of cross section of the belt; e, the base of the Naperian system of logarithms, 2.71828; Φ, the coefficient of friction between the belt and the pulley; and α the lesser arc of contact of belt on pulleys expressed in radians.

Mr. Barth gives the following specific formula for the loss of effective tension in a belt, due to its centrifugal force:

$$t_c = 0.000003454\,V^2,$$

in which V equals the velocity of the belt in feet per minute.

The formula for the effective pull of a horizontal belt is $p = t_1 - t_2$. From the equations given above an expression of p in terms of t_0, V, and α may be found, but the resulting equation is solvable by trial only. Mr. Barth, however, gives an elaborate diagram by which the solution may be effected graphically. The formula for the pulling power of vertical belts in terms of the initial tension is much simpler and offers no special difficulty in computation.

Besides the diagram mentioned, Mr. Barth gives two diagrams showing the relations of pulling power to tensions at all speeds for a belt of 1 square inch section, a diagram showing the horse power output corresponding to the belt pulls in these diagrams, and an elaborate diagram so combining and modifying the data contained in the three that the solution of almost any problem relating to belting of any size and any arc of contact can be found from it. The derivation of the first two of these four diagrams Mr. Barth describes as follows:

"In his paper, 'Notes on Belting,' read before the American Society of Mechanical Engineers in 1893, Mr. F. W. Taylor showed the economy of running belts under much lower tensions than those commonly figured on in proportioning a belt to do a certain amount of work. He also divided the belts with which he dealt into two classes: those whose dimensions he could not well increase over what he found in use, such, for instance, as the cone belts on lathes and other machines provided with a cone pulley in a limited space; and those he could readily increase by providing larger pulleys, such as the belts leading from lineshafts to the countershafts of machines.

"For belts in the first class he adopted higher tensions than for those in the

second class. He also devised a set of belt clamps provided with spring balances, by means of which he could make sure that a belt was put up under a specified initial tension at any time desired.

"The reason why Mr. Taylor had adopted, and accordingly recommended, lower belt tensions than usually counted on in proportioning a belt to do a certain amount of work, was that a belt quickly loses its tension if it exceeds a certain amount, and thus in order to maintain such a tension, approximately, requires frequent retightening, which is a source of too much expense and leads to a rapid destruction of the belt.

"Taking Mr. Taylor's data as a starting point, Mr. Barth has finally adopted the rule, as a basis for his use of belts on belt-driven machines, that for the driving belt of a machine the minimum initial tension must be such that when the belt is doing the maximum amount of work intended, the sum of the tension on the tight side of the belt and one-half the tension in the slack side will equal 240 pounds per square inch of cross-section for all belt speeds; and that for a belt driving a countershaft, or any other belt inconvenient to get at for retightening or more readily made of liberal dimensions, this sum will equal 160 pounds.

"Further, the maximum initial tension, that is, the initial tension under which a belt is to be put up in the first place, and to which it is to be retightened as often as it drops to a minimum, must be such that the sum defined above is 320 pounds for a machine belt, and 240 pounds for a countershaft belt or a belt similarly circumstanced.

"The reason for adopting a uniform sum of the tension in the tight side and one-half the tension in the slack side, as mentioned above, instead of either a uniform initial tension, or a uniform maximum tension alone, is that the aim has been to get as uniform periods as possible for retightening of belts.

"But, evidently, while the maximum tension in a belt must be the greatest factor in determining the rapidity with which the belt will lose its tension as a whole, the accompanying tension in the slack side must also have some influence, though not proportionally to the same extent; and hence the idea occurred of taking it into account in the manner and to the extent stated."

For vertical belts this condition is expressed by the equation $t_1 + {}^1/_2\, t_2 = A$, a constant having the values above stated. From a combination of this formula with some of those already given, the following are derived:

$$t_1 = \frac{2A + p}{3}$$

$$t_2 = \frac{2A - p}{3}$$

$$t_0 = \frac{4A - p + \sqrt{(4A - p)^2 - 9p^2}}{12}$$

These formulae are the ones from which the first two diagrams are plotted for values of A of 240 and 160 pounds. Except for belts of extraordinary length the last formula applies to horizontal as well as to vertical belts.

COAL MINING IN THE PHILIPPINES.

A REVIEW OF THE PRESENT CONDITION AND POSSIBILITIES OF THE INDUSTRY.

J. B. Dilworth—American Institute of Mining Engineers.

WITH the exception of an insignificant amount mined on Batan Island the coal supply of the Philippines is drawn wholly from Australia, Japan and the United States. Large deposits of coal, however, though of a somewhat inferior grade, occur in several of the islands and from present indications coal mining is likely within a few years to become an important industry. Mr. J. B. Dilworth in a paper read before the American Institute of Mining Engineers and published in the *Bulletin* for January gives the following interesting review of its possibilities.

"Outcrops of coal have been discovered in many localities in the Philippine archipelago, and practically all of the larger islands contain deposits of this mineral. Very little prospecting has been

done to determine the value of the various coal-bearing areas, but so far as known, the largest and most promising fields are found: (1) in northern Cebu; (2) in the small island of Batan, a part of the province of Albay in southeastern Luzon; (3) in the somewhat larger island of Polillo, off the east coast of Luzon, and (4) in southern Mindoro, near the small coast town of Bulalacao. Northern Panay, south-central Cebu, and various localities in southern Luzon, Masbate, Negros, and Mindanao also afford evidences of the existence of coal-beds, the extent and value of which have not yet been proved.

"Some of these coal-fields have been known for many years (coal was discovered in Cebu in 1827 and in Batan in 1842), and several futile attempts were made by the Spaniards to operate mines in these districts. But owing to many circumstances, chief among which were indifferent management, the political unrest of the islands, natural difficulties of transportation, and those inherent in the mining of steeply inclined and somewhat irregular seams, no considerable output was ever obtained from any of these mines, and the fuel required in the many departments of industrial and political life has continued to be drawn largely from Australia and Japan.

"These conditions exist to a great degree at present, and though much interest in the coal-deposits of the Philippines has been aroused within the last few years, and considerable development-work has been carried on, there is now but one mine regularly supplying coal to the trade. This mine, operated by A. U. Betts, on the southeast coast of Batan Island, began in a very primitive way in the latter part of 1906, and when visited in the spring of 1907 had a daily capacity of about 25 tons. All of this output was taken by local steamers and had no effect on the general market.

"The present annual consumption of coal in the Philippines approximates 350,000 long tons. Of this amount, 300,000 tons is imported from Australia and Japan for use by inter-island steamers, railroads, factories, ice- and distilling-plants, etc.; the remaining 50,000 tons is high-grade steam-coal, chiefly from the Pocahontas field in Virginia and West Virginia, which is brought 'around the Horn' for use by the United States Navy, and with which the native coal cannot hope to compete.

"Consumption is increasing yearly as new railroads are completed, new industrial plants installed, and both foreign and inter-island commerce increased under the aggressive policy of American interests now developing in all parts of the archipelago. It is expected that, within the next four years, 650 miles of railroad will be operating in Luzon and the Visayan, or central, belt of islands, a mileage more than four times as great as that now in use. Several hundred steamers call at the various ports each year, most of which now coal in foreign harbors with high-priced fuel of a grade not greatly superior to that found in several of the Philippine fields. An annual consumption of more than 500,000 tons within the next five years seems, therefore, to be a conservative estimate, which will assure a home-market for the output of several large coal-mines.

"The native coal is somewhat inferior to imported coals, owing to its generally higher percentage of moisture and consequent lower calorific value; nevertheless, it is believed that the better grades can be substituted in every place where Australian and Japanese coal is now used. This fact, in connection with the well-based estimate that native coal can be delivered in the principal ports of the archipelago at a price of from 50 to 60 per cent. of the lowest prices of competing foreign coals, leads to the conclusion that well-managed mining operations in the better native fields should have no difficulty in disposing of their output, and eventually in dominating the home-market, in addition to the possibilities of building up a subordinate trade with the neighboring ports of Singapore, Hongkong, and Shanghai, all consumers of large quantities of Australian and Japanese coal.

"There has been considerable speculation on the part of those interested in mining and other industrial operations in the Philippines as to the suitability of the Filipino as a laborer. Until recently the opinion prevailed that he was too

indolent and irresponsible and had too many 'feast-days' on his calendar to make an efficient and reliable miner or day-laborer.

"This early belief is fading out in the light of experience, and large and important contracts for harbor-improvements, railroad-construction, and other public works are being successfully carried out by those employing thousands of natives as unskilled laborers. In the old Spanish mines natives were employed extensively, and in the preliminary prospecting and mining now being conducted in various places Filipinos are employed both underground and on the surface.

"Undoubtedly, the native miner will not prove as strong or as efficient as the Japanese or American miner; but neither will he expect as much pay, and, if fairly treated and directed by white bosses, he will probably put out more coal per dollar of wages received than the more skillful miner, and be a peaceful and persevering worker.

"Wages vary considerably in different localities, due to the varying density of population and the natural resources of the district. In the island of Cebu, which is very thickly settled by relatively poor inhabitants, the unskilled laborer receives 30 cents per 10-hour day, while the more responsible positions—such as watchmen, firemen, blacksmith and carpenter helpers—pay from 50 cents to $1 per 10-hour day. In southern Luzon, where there is a great demand for laborers in the hemp-plantations and warehouses, wages are about double those paid in Cebu.

"It is impossible to estimate very accurately what will be the ultimate cost of mining in any one field, both by reason of the insufficient data as to the structure and character of the rock-strata and coal-seams, and because no accurate costs of the various items involved can be obtained from mines in actual operation under like conditions. Assuming a steeply-dipping seam of 7 feet thickness, modern mining-methods, wages approximating those now paid in Cebu, and a daily output of 500 tons, it is believed that coal can be delivered at the mine-mouth for $1 per ton.

"Transportation and storage charges would vary with each locality, and would have to be computed especially for the case in hand. As a general rule, however, coal from any of the known fields in the islands should be put in Manila harbor at a cost not exceeding $2.50 a ton, where it would have to compete with foreign coal, of 25 per cent. great calorific power, selling under normal conditions at from $4 to $4.50 per ton. (Since the Russo-Japanese war, Australian coal has monopolized the Philippine market, with a consequent increase in price to $5.90 per ton in 1906.) On this basis of relative cost and fuel-efficiency, it seems as though successful competition with foreign fuel would not be difficult."

THE ELECTROLYTIC RECOVERY OF ZINC.

A DESCRIPTION OF A SUCCESSFUL PROCESS FOR THE RECOVERY OF PURE ZINC FROM ORES BY ROASTING, LEACHING AND ELECTROLYTIC DEPOSITION.

Walter Stoeger—The Mining Journal.

A GREAT deal of research has been expended during recent years in the endeavor commercially to apply the electric current to the reduction of zinc from its ores in both electrothermic and electrolytic processes. The extraction in the ordinary processes of zinc metallurgy is very unsatisfactory; in fact, low grade ores cannot be worked at a profit at all. The electric furnace, with its high temperatures and continuity of operation, is able to effect a somewhat higher extraction than that obtained in the older processes, but the product requires so much further treatment that the electrothermic process really amounts to nothing more than an enrichment. It is at best a very expensive method of reduction. The wet electrolytic processes gave much promise of success but the difficulties which developed in practice have prevented their commercial application. Only one of the wet processes so far proposed, says

Herr Walther Stoeger in *The Mining Journal* for January 30, has proved a practical and commercial success. We give a brief abstract of his description.

"The only processes admitting of simple application are those employing sulphuric acid. Broadly speaking, the *modus operandi* of these processes is as follows: Zinc blende is roasted, and is then lixiviated with dilute sulphuric acid, calamine being treated direct with the acid. The liquor is carefully purified, and the zinc is deposited by the electric current, the zinc-free acid liquor being used over again for fresh quantities of ore. Though the entire process is apparently simple, numerous difficulties arise in connection with its various details, with the result that only the process described below has been found to stand the test of practical application.

"The method of roasting for other sulphuric acid processes differs from the usual metallurgical practice, inasmuch as zinc sulphate, not being reduced to the metallic state by distillation, its formation must be prevented as far as possible, in order to avoid loss of metal. In the process now under consideration, however, the resulting zinc sulphate, so far from being detrimental, is really desirable, since its enables the loss of sulphuric acid to be counteracted to a greater or smaller extent. If the consumption of sulphuric acid be high, the ore is preferably roasted in thick layers at a moderate temperature, in order to increase the formation of sulphate; but where the consumption of acid is small, a portion of the ore is roasted somewhat more strongly, so as to obtain a quantity of sulphate corresponding to the acid consumption, and to avoid an excess of acid. Owing to the relatively low roasting temperature, the consumption of fuel is small (about 10 per cent. of the weight of the ore); and as the wear and tear of the furnace fittings is reduced, mechanical furnaces can be employed with advantage. Moreover, the low temperature prevents any loss of zinc or silver by volatilisation. Ores that sinter at the usual high roasting temperature, and thus resist the extraction of the sulphate, can be worked up without difficulty by the electrolytic process.

"In the case of ferruginous ores, it is essential that no ferrous oxide should be formed in the roasted product, but only ferric oxide. Provided the roasting be properly conducted, the higher oxide is invariably formed; and therefore the presence of iron is not a source of difficulty; ferric sulphate being decomposed at a relatively low temperature is absent from the finished product.

The leaching process is carried on in a systematic manner, the acid from the storage tanks acting first on the partly extracted ore and lastly on the fresh ore. Prolonged contact of the ore and acid is not advisable; it is found that a thorough mixing of the two by wooden stirrers gives much better results. The separation of the ore and liquor is effected by aspiration or in filter presses. The ore is thoroughly washed with water but a certain amount of acid is always lost in the residue. Soluble gangue constituents also consume a certain quantity of acid. In the case of zinc blende with only a small amount of soluble gangue, the loss of acid in this way may be compensated for by the zinc sulphate formed by careful roasting; with calamine and with blende in gangue high in soluble constituents, however, an addition of sulphuric acid will always be necessary. An accurate estimate of the amount of acid necessary in an extreme case, a calamine ore, containing 7 per cent. of zinc in a lime gangue, allows 2 tons of acid per ton of pure zinc produced.

The purification of the liquor is a simple matter. Lead does not go into solution at all. Any ferrous oxide present can be converted into ferric oxide by blowing air through the solution, final traces being oxidised by the addition of a little permanganate. The ferric oxide is precipitated by the zinc oxide in the ore provided the leaching is conducted in the manner indicated above. Other metals, such as copper, cadmium, arsenic, etc., usually present in only small quantities, are precipitated by hydrogen sulphide. Any silver present in the ore is left in the residue from which it may be recovered easily by further leaching.

"The foregoing methods of purification eliminate all extraneous metals in the liquor except manganese, which cannot

be precipitated unless by methods that are too troublesome to carry out in practice. Although in most cases the percentage of manganese in the ore is low, it soon collects in the liquor during the repeated use of the latter, and consequently the electrolysis must be conducted in such a manner that the manganese cannot do any harm. If manganiferous zinc lyes are electrolysed by the aid of insoluble anodes—such as are necessary in the recovery of zinc—without the adoption of special precautions, the liquor very soon turns a dark red colour, owing to the production of permanganic acid by the nascent oxygen liberated at the anode. The zinc deposited on the cathode is corroded by this acid, and is eaten into holes that increase even while the current is passing, so that the recovery of zinc becomes impossible by this means. This inconvenience, however, may be obviated by the method patented by Dr. Laszczynski, and largely employed in the electrolytic recovery of copper, without any necessity for having recourse to diaphragms or other complicated devices.

"When the anode is covered with a close-fitting layer of some fabric that is permeable to liquids, the liquid will remain perfectly colourless throughout the electrolysis, that is to say, no permanganic acid is formed, and the zinc is deposited in a pure state, and to a quantitative extent closely approximating to the theoretical yield furnished by the current employed. This result is due to the circumstance that the liquid in the wrapping is in a perfect state of quiescence, even though the remainder of the electrolyte be in motion, and that the manganese sulphate cannot be oxidised to permanganic acid except in the immediate vicinity of the anode, this being the only place where nascent oxygen is to be found. Moreover, manganese ions are cathions, and therefore travel toward the cathode, so that, in a comparatively short time after the completion of the circuit, no manganese is present in the immediate vicinity of the anode. Now the fabric retains the liquid firmly, so that no fresh manganiferous liquor can reach the electrode, and consequently none of the manganese can be converted into permanganic acid there. Since this is the case, as is evidenced by the colour of the liquor, the corrosion of the zinc by permanganic acid is precluded.

"The vats for the electrolytic process are constructed of wood, lined with lead, and eight cathodes and nine anodes are suspended in each. The cathodes are of zinc, and are connected to a wooden traverse by strips of conductive material. The anodes are of sheet lead, and are wrapped in a close-fitting cover of suitable fabric, being also suspended from a wooden traverse. The current leads are formed by copper rails, mounted on the sides of the vat, one of them being provided with branches leading to the cathodes, and the other with branches leading to the anodes. Stirrers, operated by a crank shaft, are arranged between the anodes and cathodes.

"The bath works with a current of 1,500 amperes and 4 volts, and the daily output of zinc amounts to 91.3 pounds. Since it is not advisable to stop the flow of current for long, day and night shifts are necessary, though the current may be reduced occasionally— e.g., in the event of one of the working motors getting out of order. The baths are coupled in series, in groups of about thirty units. They are charged with zinc sulphate solution, containing, for instance, 10 per cent. of zinc, and the current is allowed to flow through this electrolyte until the zinc content has fallen to about 4 per cent. The acid previously in combination with the now deposited zinc has been liberated, so that the liquor contains about 9 per cent. of free sulphuric acid.

"This final acid liquor is drawn off and replaced by a fresh charge, and the process is repeated until the cathodes have attained a thickness of ¾ to 1⅛ inches, whereupon they are taken out and are cleaned ready for sale, fresh cathode plates being inserted in the vat, and the entire series of operations renewed. Accurate analyses of metal cut from the corner of a plate showed a zinc content of 99.97 per cent., so that the metal is unusually pure, and will therefore command a high price."

The consumption of energy is about 145 watts per kilogramme, or 147.32 kilowatts per long ton, of zinc produced per

day of twenty-four hours. For a plant turning out one long ton of electrolytic zinc per day about 250 horse power would be required for all purposes; one horse power year (350 working days) will produce 1.4 tons. The process is particularly adapted to districts where electricity can be generated cheaply from water power, but it is much more practicable for low-grade ores than the older processes even when water power is not available.

POWER FROM COPPER BLAST-FURNACE GAS.

THE UTILIZATION OF THE FLUE GASES IN GAS ENGINES IN THE MANSFIELD DISTRICT.

Robert Schorr—The Engineering and Mining Journal.

AN important feature of the copper-smelting practice in the famous Mansfield district, near Eisleben, Germany, is the attention given to the recovery and utilization of by-products. The ores are comparatively low-grade, the average yield per ton of the 676,414 tons charged in 1907 being 2.847 per cent. copper and 0.0155 per cent. silver, and the mining and reduction costs are very high, about $9 per ton. The recovery of waste products has been so highly developed that in 1907 the total revenue from the sale of slag brick, sulphuric acid and ferrous sulphate amounted to almost 3,000,000 marks. One of the latest developments is the application of the blast-furnace gases to driving gas engines. We take the following description of the plant and of its results from an article by Robert Schorr in *The Engineering and Mining Journal* for February 27.

"In former years the waste furnace gases were used for raising steam and for heating the blast. The furnace gases at the Krug, Koch and Eckardt works have a heating value of from 590 to 630 calories per cubic metre, but in the Kupfer-Kammer works they are considerably poorer. So far only the Krug-hütte has been equipped with gas engines. These are directly connected with electric generators which furnish a three-phase current of 50 cycles and 3,000 volts. Underground cables are employed for distribution. The Krug furnaces smelt at an average of 636 tons of ore daily or 26½ tons an hour. For every ton of ore approximately 800 cubic metres or 28,250 cubic feet of gas are evolved, or 21,000 cubic metres, 748,680 cubic feet, per hour for the whole charge. These quantities vary to some extent, depending entirely upon how the furnaces are operated.

"The gas supply is fairly steady, as it is aimed never to have more than one of the four furnaces cut off from the mains; it is necessary to cut off the furnace while feeding. The average heat value of these gases is 600 calories per cubic metre, or about 68 B. t. u. per cubic foot. This is about two-thirds of the calorific value of an average gas from iron blast furnaces, which always contains 1¾ to 2 per cent. of hydrogen; copper-furnace gas carries no hydrogen and consists of 9.2 to 10.8 per cent. carbon dioxide, 19 to 24 per cent. carbon monoxide, the remainder being nitrogen. The fluctuation in heat value amounts to about 10 per cent.

"In view of the large power expenditure required for cleaning the gas and for the compressing of such lean charges in the engine itself, it will not be safe to figure on less than 2700 calories, or 10,711 B.t.u. per effective horsepower-hour, corresponding to a gas supply of 4½ cubic metres, or 159 cubic feet. The heat equivalent of one horsepower being 736 calories or 2545 B.t.u., we have $2545 \div E. 10{,}711$ or the thermal efficiency of the gas engine $E. = 23.76$ per cent. Better performances are on record, established by careful tests made under ordinary conditions and without previous cleaning of valve chests and cylinders. Since 21,200 cubic metres of gas is available per hour, this represents a total of $21{,}200 \div 4.5 = 4700$ horsepower equivalent or continuously 7.4 horsepower equivalent for every ton of ore treated in 24 hours. The power equivalent for every ton of copper made in 24 hours is then $7.4 \times 37 = 273.8$ horsepower, since 37 tons of ore are smelted

for every ton of copper produced. In all more than 41,000,000 horsepower hours, or more than 30,000,000 kilowatt-hours could be generated at the Krughütte alone.

"The gas as it leaves the four furnaces is entirely unsuitable for direct use in gas engines, because it contains 17 grams of dust per cubic metre, and also sulphur, arsenic, potassium, cyanide, etc. It is therefore, first cleaned, the two gas mains feeding from the furnaces to Theisen gas washers. There are three washers housed in one building; two have a capacity of 6500 cubic metres of gas per hour each, and one is built for 15,000 cubic metres. This makes a total capacity for the whole installation of 28,000 cubic metres of gas per hour. The temperature of the entering gases is about 300 degrees C. or 752 degrees F. About 25 gallons of water are required for every 1,000 cubic feet of gas, or about three litres per cubic metre. The power consumption for every 1,000 cubic metres is at an average 6 horsepower, or above 2¾ per cent. of the power represented by the purified gases.

"The gas contains, after cleaning, only 0.003 to 0.005 gram solid matter per cubic metre. The water from the washers is run into large settling tanks, the deposits in which carry up to 25 per cent. lead. The deposits are filter-pressed and treated for lead and silver with the balance of the flue dust, as obtained from the chambers in the furnace building.

"In the original installation, the gases, after leaving the washing plant, were passed into a gasholder of 500 cubic metres capacity. More recently a second holder of 400 cubic metres has been added, and also gas filters placed at the engine house. These filters are similar in construction to an ordinary scrubber, but they are arranged horizontally, and instead of wooden trays, beds of iron turnings are placed vertically at intervals. The gas leaves the filters with a temperature of 21 degrees C., and it is under a pressure varying from 1 to 5 centimetres of water column.

"The first installation of two 125-horsepower four-cycle Körting gas engines has been working almost steadily since 1901. The two 1,300-horsepower Oechelhauser-Borsig engines operate on a two-cycle, and are single acting. They have been continuously in commission, day and night, for more than 3½ years. The latest addition is an 1,800-horsepower two-cycle Körting engine built by the Klein Engineering Works of Dombruch. This unit was completed last April, was placed in service June 9, 1908, and has since run satisfactorily. This completes the original plan for the Krug-hütte gas-engine central station, bringing it up to a rated capacity of 4,650 horsepower. The new large engine has a stroke of 1,300 millimetres and is designed for 86 revolutions per minute; the 1,300-horsepower engines have a stroke of 950 millimetres, and make 125 revolutions per minute. All engines are directly connected to three-phase generators of 50 cycles and 3000 volts. The two smaller engines are in a separate building.

"Much trouble has been caused by fluctuations in the percentage of carbon monoxide and carbon dioxide. As long as the ratio CO_2: CO is in the neighborhood of 1 : 2 the engines work perfectly, the compression averaging 16 atmospheres, or 227.6 pounds per square inch. This is very high, and only possible with poor gas, without causing premature explosions. The work of compression is correspondingly high, amounting to about 9 per cent. of the cylinder duty. The pressure of explosion is 25 atmospheres, or 355 pounds per square inch.

"To assure a uniform quality of gas, or to permit enrichment in the case of a sudden rise in carbon dioxide, the company has installed quite recently two Pintch gas generators with a combined capacity of 3,000 cubic metres per hour. Locomotive cinders, which average about 3,500 calories per kilogram, or 6,300 B.t.u. per pound, are employed with coke breeze in the proportion of three to one, the cost of enrichment being only 2 pfennigs per kilowatt-hour. These generators are arranged for hand feeding. The generator gases pass through coolers and scrubbers, as in the usual standard gas plant, to remove tar, ammonia, etc. In view of the small quantity of gas which will be re-

quired for the enrichment of the blast furnace gases, there may have been no necessity to go to this complication and expense. It is also contemplated to use at times coke breeze and brown-coal coke screenings instead of locomotive cinders.

"The gas-engine plant of the Krughütte has been utilized to less than its full capacity, in order to avoid temporary overloads caused by the many and widely distributed secondary movers. In spite of this the financial result has been rather satisfactory. The total expenditure for operating and fixed charges in 1907 amounted to 122,512 marks, equal to about 0.67 cents per kilowatt-hour. The results in 1906 were a little better, figuring 0.51 cents per kilowatt-hour, or about $33 per horsepower-year. With the full plant in operation the average yearly load factor will be considerably higher, and a further marked reduction in the power cost will be effected."

BRIQUETTED COAL AS A LOCOMOTIVE FUEL.

RESULTS OF A SERIES OF COMPARATIVE TESTS OF NATURAL COAL AND BRIQUETTES OF THE SAME COAL PREVIOUSLY CRUSHED.

United States Geological Survey.

BULLETIN 363 of the United States Geological Survey, recently issued, gives the results of elaborate tests of run-of-mine and briquetted coal on locomotives and torpedo boats, made by the Technologic Branch of the Survey, a review of previous investigations of the same kind, and specimen specifications employed in the purchase of briquetted fuel by certain foreign railways. The locomotive tests, carried out at the testing plant of the Pennsylvania Railroad at Altoona, were designed to show the comparative values of raw coal and briquettes of the same coal previously crushed. Some very interesting results have been obtained, of which we give a brief summary taken from an abstract of the report of the engineer in charge in the *Railroad Age Gazette* for February 5.

"Many low-volatile coals are semi-smokeless and therefore very desirable for use in locomotives at or near terminals; nevertheless, on account of their low evaporative efficiency, they have not been found altogether satisfactory when used as a locomotive fuel. Their tendency to disintegrate rapidly on the grate during combustion causes large quantities of cinders and sparks of high calorific value to be discharged. These cinders accumulate in the smoke box of the locomotive, obstruct the draft and reduce the capacity of the boiler. The investigation here reported, therefore, was undertaken to determine in what measure, if any, the process of briquetting will serve as a remedy for these defects and to discover the effect of the process on efficiency and capacity.

"The coal selected for the tests was taken from a mine near Lloydell, Cambria County, Pa. The Lloydell coal is a very friable, low-volatile bituminous coal, and the carloads selected for the tests consisted of run-of-mine. The coal was exposed to the weather for 30 days on the way to the St. Louis testing plant, before being briquetted. It showed but little change due to this exposure except a decided increase in moisture, which, however, was eliminated in the briquetting process.

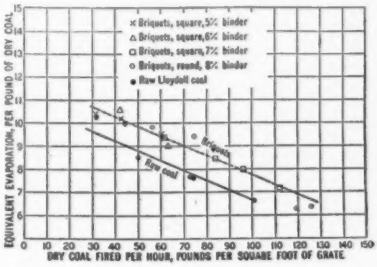
"The briquettes tested were of two sizes, and the amount of binding material in them ranged from 5 to 8 per cent. The larger size, called in the tests square, was rectangular in form, about 3 inches by 4¼ inches by 6¾ inches, with slightly rounded corners, and weighed about 3½ pounds. The smaller size of briquettes, called 'round,' was cylindrical with convex ends, had a diameter of about 3 inches and a length over the convex ends of 2 inches and weighed about ½ pound. The binding material in all the briquettes was water-gas pitch. This material was furnished at the briquetting plant of the United States Geological Survey, in St. Louis, at $9 per ton, or 0.45 cent per pound. The least amount of binding material that would make perfect briquettes was found to be

5 per cent. of the weight of the coal. The cost of the binder in one ton of the 5 per cent. briquettes was therefore $0.45.

"The cost of briquetting, including all charges, is estimated to be about $1 per ton of briquettes; that is, the briquetting added approximately $1 per ton to the cost of the coal. The briquettes were made, however, in an experimental plant, and the price is for this reason probably not so low as if they had been made on a much larger scale. In the process employed the binding material is mixed with the crushed coal, the mass is softened by contact with steam as it passes to the briquetting press, and the briquette is finally formed in a compressing machine.

"The locomotive used for all tests was a simple Atlantic (4-4-2) type passenger locomotive of the Pennsylvania Railroad, class E2a. This engine had cylinders 20.5 inches diameter, with a piston stroke of 26 inches. Its firebox heating surface was 156.86 square feet and the tubes 2,162.4 square feet; totaling 3,319.26 square feet. The steam pressure was 205 pounds per square inch. In order to obtain results covering all practical rates of evaporation up to the limit of the boiler capacity, tests were made with each style of briquettes and with the natural coal under the following conditions of running: First, a low evaporation test at 80 revolutions per minute and 15 per cent. cut-off; then a high evaporation test of 120 revolutions per minute and 20 per cent. cut-off; next a still higher evaporation test at 160 revolutions per minute and 25 per cent. cut-off; and finally a test made at the maximum possible evaporation. With the briquetted coal this maximum-capacity test was at 200 revolutions per minute and 32 per cent. cut-off. Four, or at most five, tests were thus sufficient to cover the range of boiler capacity."

Analyses made on carefully selected samples from carload lots of the coal and on briquettes of several qualities show that the coal contains more fixed carbon and moisture and less volatile matter and ash than the briquettes from the same coal. The calorific value per pound of dry fuel seems to be greater for the natural coal than for the briquettes, notwithstanding the fact that the binder used in making the briquettes has a higher heating value than the coal.


× Briquets, square, 5% binder
△ Briquets, square, 6% binder
□ Briquets, square, 7% binder
○ Briquets, round, 8% binder
● Raw Lloydell coal
EQUIVALENT EVAPORATION, PER POUND OF DRY COAL.
DRY COAL FIRED PER HOUR, POUNDS PER SQUARE FOOT OF GRATE
Raw coal
Briquets

In the diagram above is shown the equivalent evaporation per pound of dry coal plotted against the rate of combustion. The figure presents a comparison under the same test conditions between the natural Lloydell coal and the same coal briquetted. It shows that a well defined improvement in the evaporation per pound of fuel is obtained by briquetting. When the comparison is made on the basis of evaporation per square foot of heating surface, the better results for briquetting are further emphasized. The following table derived from a diagram plotted on this basis gives a comparison of the different fuels at equal rates of evaporation. The diagram shows that the maximum evaporation possible with the natural Lloydell coal is 16 pounds per square foot of heating surface per hour, but with the same coal briquetted the evaporation is more than 19 pounds.

COMPARISON OF COAL AND BRIQUETTES AT EQUAL RATES OF EVAPORATION.

	Pounds				
Evaporation per square foot heating surface per hour	8	10	12	14	16
Equivalent evaporation per pound of fuel:					
Natural Lloydell coal	9.5	8.8	8.0	7.3	6.6
Briquetted Lloydell coal	10.7	10.2	9.7	9.2	8.7

Though less significant than comparisons of boiler performance, on account of the many variable factors introduced, the comparisons of engine efficiency in terms of coal per dynamometer horsepower hour give interesting results. Curves plotted on this basis show that whatever may be the power developed the briquettes give the greater efficiency, but that when the power is extremely

low or extremely high the difference is small. At the point of maximum efficiency the difference amounts to nearly 35 per cent.

The weight of cinders collected in the smoke box was about the same for the natural coal as for the briquetted coal at all rates of combustion. The sparks from the stack, when the locomotive was fired with briquettes, were in the form of flakes considerably larger than those discharged when coal was fired. The calorific value of both cinders and sparks, however, is in general higher for the natural than for the briquetted coal. It is noticeable that the difference in heat losses increases as the rate of evaporation increases; and, further, that the loss due to cinders and sparks decreases slightly as the percentage of binder used in the briquettes is increased.

The density of the smoke from the locomotive was compared with the Ringlemann charts. An examination of the results of the observations shows that for a given boiler capacity more smoke is made when raw coal is fired than when briquettes are fired. The density of the smoke made with briquette firing is nearly constant for all capacities under 90 per cent. of full load; for capacities beyond this point the density increases rapidly. The amount of smoke made when briquettes are fired seems to increase slightly with the percentage of binder used, due no doubt to the fact that the binding material employed consists largely of volatile matter. The tests have shown that a considerable degree of smoke control is possible when briquettes are used under the adverse conditions of intermittent running to which a locomotive is subjected in terminals.

"Briquettes of both small and large size were fired with the ordinary shovel and were handled in much the same manner as coal. In all tests they were fired alone without mixing with coal. It was not necessary to break the briquettes in order to handle them readily with the ordinary scoop shovel, and the unbroken briquettes burned freely and completely. They disintegrated slowly from the heat of the flame and became more or less porous as they swelled and opened under the action of the heat.

"To observe the effect on briquettes of exposure to the weather, a number of the round and square briquettes were placed on the roof of the testing plant. After four months of exposure for the round and three months for the square briquettes, no change whatever from their original condition was noticed. They appeared to be entirely impervious to moisture and were still firm and hard.

"The briquettes were little affected by handling. They were loaded at St. Louis in open gondola cars and shipped to Altoona, where they were unloaded by hand and stacked. They were handled a third time in taking them to the firing platform of the test locomotive. After these three handlings they were still in good condition, very few were broken, and the amount of dust and small particles was practically negligible.

"The results of the tests justify the following conclusion:

(*a*) The evaporation per pound of fuel is greater for the briquetted Lloydell coal than for the same coal in its natural state. This advantage is maintained at all rates of evaporation.

(*b*) The capacity of the boiler is considerably increased by the use of briquitted coal.

(*c*) Briquetting appears to have little effect in reducing the quantity of cinders and sparks; the calorific value of these, however, is not so high in the briquetted as in the natural fuel.

(*d*) The density of the smoke with the briquetted coal is much less than with the natural coal.

(*e*) The percentage of binder has little influence on smoke density.

(*f*) The percentage of binder for the range tested appears to have little or no influence on the evaporative efficiency.

(*g*) The expense of briquetting under the conditions of the experiments adds about $1 per ton to the price of the fuel, an amount which does not seem to be warranted by the resulting increase in evaporative efficiency.

(*h*) With careful firing, briquettes can be used at terminals with a considerable decrease in smoke.

(*i*) The briquettes appear to withstand well exposure to the weather, and suffer little deterioration from handling."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

The Stability of Arches. Henry Adams. Read before the Civ. & Mech. Engrs' Soc. A graphical study of the stresses. Ills. 3500 w. Surveyor—Feb. 12, 1909. No. 2585 A.

Conventional Live-Load Position for Maximum Stresses in Arches. William Cain. Investigates a given arch. 1500 w. Eng News—Feb. 4, 1909. No. 2275.

Bascule.

An Ornamental Bascule Bridge; Trunnion Bascule Across Coopers Creek, at Federal St., Camden, N. J. J. B. Strauss. Illustrated detailed description. 3500 w. Eng News—Feb. 4, 1909. No. 2272.

Cantilever.

See Viaducts, under Bridges.

End-Launching.

Erection of the French River Bridge of the Canadian Pacific Railway. Illustrates and describes the conditions, and methods of erecting by end-launching a bridge of one 415-ft. riveted through truss span and two 60-ft. deck-plate-girder spans. 2500 w. Eng Rec—Jan. 30, 1909. No. 2176.

We supply copies of these articles. See page 159.

Quebec.

Secondary Stresses in Large Span Bridges. Editorial review of the report of C. C. Schneider to the Quebec Bridge Commission, discussing the cause of the failure and the best course to be pursued in replacing the structure. 2500 w. Engng—Jan. 29, 1909. No. 2361 A.

Reinforced Concrete.

Construction Methods on Two Highway Bridges, Nashville, Tenn. Detailed description, principally of the piers and the viaduct approaches of reinforced concrete, of the Sparkman and the Jefferson St. bridges. Ills. 2800 w. Eng Rec—Feb. 13, 1909. No. 2449.

Concrete Work on Sparkman St. Bridge, Nashville, Tenn. W. F. Creighton. An illustrated article describing particularly the reinforced-concrete approaches, and concrete piers. 8600 w. Eng News—Feb. 25, 1909. No. 2753

An Economical Long Span Reinforced Concrete Highway Bridge. William J. Watson. Read before the Ohio Engng. Soc. Illustrates and describes a bridge recently completed over the Vermillion River, at Wakeman, Ohio. 3500 w. Engng-Con—Feb. 24, 1909. Not. 2767.

The Pyrimont Bridge Over the Rhone (Pont en Béton armé sur le Rhone, à Pyrimont). G. Espitallier. Illustrated description of this concrete arch bridge on masonry piers. 3500 w. Génie Civil—Jan. 16, 1909. No. 2640 D.

See also Steel, Trestles, and Waterways, under BRIDGES.

Skew Portals.

The Detailing of Skew Portals. J. P. Davies. Gives formulae for the computation, directions for layout, etc. Diagrams. 3000 w. Eng News—Feb. 11, 1909. No. 2397.

Steel.

A Simplified Method for the Graphical Calculation of Bridge Trusses. J. H. Griffith. Explains a method for the graphical calculation of chord and web stresses. 700 w. Eng News—Feb. 25, 1909. No. 2762.

Diagrams for Rivet Pitch in Loaded Girder Flanges. P. L. Pratley. Diagrams and explanatory notes. 700 w. Eng News—Feb. 18, 1909. No. 2524.

Live Loads and Working Stresses in Railway Bridges. Conrad Gribble. Compares present and past conditions. 3000 w. Cassier's Mag—Feb., 1909. No. 2330 B.

Central of New Jersey Bridge Renewal at Bethlehem. Plan, photographs, and description of the old and new structures, and of the methods of erection. 900 w. R R Age Gaz—Feb. 5, 1909. No. 2298.

The Communipaw Avenue Bridge, Central Railroad of New Jersey. A 200-ft. highway bridge, spanning seven tracks in Jersey City, erected without interruption to traffic. 1000 w. Eng Rec—Feb. 13, 1909. No. 2453.

The Sparkman and Jefferson Street Bridges, Nashville, Tennessee. Illustrated detailed description of two long, high bridges over the Cumberland River, of three steel-truss spans and reinforced concrete viaduct approaches. 2500 w. Eng Rec—Feb. 6, 1909. No. 2303.

A Protected Steel and Concrete Highway Bridge. Illustrates and describes a bridge carrying Tremont Ave. over a number of tracks of the N. Y., N. H. & H. R. R. and is of interest on account of the heavy construction and for details of the concrete floor and concrete protection of the steel from locomotive gases and corrosion. 1200 w. Eng Rec—Feb. 20, 1909. No. 2563.

The Replacement of the Humboldt Harbor Bridges in Berlin (Die Auswechselung der Humboldthafen-Brücken in Berlin). C. Müller. Describes the work of rebuilding and the new structure. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1909. No. 2842 D.

Trestles.

The Design, Construction, and Cost of a Reinforced Concrete Trestle. C. C. Mitchell. Illustrated description and information concerning the construction of a reinforced concrete incline on Catskill Mountain, N. Y. 3500 w. Eng Rec—Feb. 20, 1909. No. 2568.

Viaducts.

I. The Erection of the Pwll-y-pant Viaduct on the Brecon and Merthyr Extension of the Barry Railway. Alexander Low Dickie. Illustrated detailed description of the work. II. Notes on the Erection of Cantilever Bridges. Thomas Claxton Fidler. Two papers discussed together. 11800 w. Inst of Civ Engrs. No. 3596 & No. 3740. No. 2797 N.

Waterways.

A Comparison of Bridge Waterways. Daniel B. Luten. Read before the Indiana Engng. Soc. A comparison of the rectangular, the egg-shape, and the arch types, with special reference to reinforced-concrete construction. Ills. 2500 w. Munic Engng—Feb., 1909. No. 2336 C.

CONSTRUCTION.

Beams.

Oblique Loading. W. S. Kinne. Gives graphical methods for the solution of the general problem of flexure of straight beams of uniform cross-section for loads in any plane. 4000 w. Wis Engr—Dec., 1908. No. 2733 D.

See also Reinforced Concrete, under CONSTRUCTION.

Brick.

See Concrete Blocks, under CONSTRUCTION.

We supply copies of these articles. See page 159.

Coal Pockets.

Ferro-Concrete Coal Storage Plant. Illustrated description of coal silos and their mechanical equipment as installed at the Clayton West and Skelmanthorpe Collieries. 1000 w. Col. Guard—Jan. 22, 1909. No. 2216 A.

Columns.

The Theory of Eccentrically-Loaded Columns, Including the Influence of Shear Distortion. Harry S. Prichard. Gives problems and results of special cases showing the influence of shear on deflection and illustrating the theory of eccentrically loaded columns. Mathematical study. 4000 w. Eng News—Feb. 25, 1909. No. 2755.

Concrete.

Concrete Construction in Water Works. William Curtis Mabee. From a paper before the Ind. Engng. Soc. Remarks on its peculiarities and the importance of intelligent supervision. 1500 w. Munic Engng—Feb., 1909. No. 2337 C.

See also Contracts, under CONSTRUCTION.

Concrete Blocks.

The Cost of Cement Block Walls Compared with the Cost of Brick Walls J. A. Smith. A collection of cost data and a comparative statement. 2500 w. Engng-Con—Feb. 3, 1909. No. 2295.

See also Fireproof, under CONSTRUCTION; and Sewers, under MUNICIPAL.

Concrete Tiles.

The Pauly Concrete Hollow Tile. Information concerning the manufacture and use of this material Ills. 900 w. Cement Age—Feb., 1909. No. 2729.

Contractor's Plants.

See Sewers, under MUNICIPAL.

Contracts.

Maintenance and Defect Clauses. Considers clauses for the protection of employer and of contractor necessary in contracts. 1600 w. Engr, Lond—Jan. 22, 1909. Serial. 1st part. No. 2222 A.

Concrete Structures from the Viewpoint of the Contracting Specialist. DeWitt V. Moore. Deals with the modern use of concrete for construction. 5000 w. Cal Jour of Tech—Jan., 1909. No. 2711.

Earthquakes.

Construction to Withstand Earthquakes (Le Case che non crollano). A. Danusso. A discussion inspired by the recent disaster in Sicily. Ills. 6000 w. Il Cemento—Jan. 15, 1909. No. 2652 D.

Excavation.

Comments on the Use of Wagons in Transporting Earth. Considers different styles of wagons and methods of loading them. 3000 w. Engng-Con—Feb. 3, 1909. Serial. 1st part. No. 2296.

See also Rock Removal, under WATERWAYS AND HARBORS.

Fireproof.

Unburnable Homes, Their Artistic and Architectural Possibilities. Benjamin A. Howes. Discusses especially the use of reinforced concrete for residences. 3000 w. Cement—Jan., 1909. No. 2726 C.

Fireproof Stucco Construction. Mentor Wetzstein. Discusses concrete block stucco houses as fire resistant material, giving illustrations showing the artistic possibilities. 1000 w. Cement Age—Feb., 1909. No. 2728.

Foundations.

Machinery Foundations. Hints on foundations for machinery, and for structures such as bins, bunkers, hoppers, etc. 2000 w. Mech Wld—Jan. 22, 1909. No. 2214 A.

Foundations for the New Building and Pumps, Lake View Pumping Station, Chicago. A detailed description of the construction work. Ill. 4000 w. Eng Rec—Feb. 13, 1909. No. 2448.

The Settlement of the Magistrates' Courts, Georgetown, British Guiana. Leonard Percival Hodge. Describes a case where a building was allowed to settle under constant observation. Ills. 1200 w. Inst of Civ Engrs—No. 3735. No. 2793 N.

Grain Elevators.

The Concrete Grain Elevator of the Pennsylvania Railroad at Baltimore. Illustrated description of an interesting concrete structure, and of the system of belt conveyors for handling the grain. 2000 w. Eng Rec—Feb. 20, 1909. No. 2561.

Piling.

Straight or Tapered Concrete Piles? Clarence S. Howell. Describes methods of manufacture, and gives a comparison between straight and tapered piles as to load capacity. 1600 w. Eng News—Feb. 25, 1909. No. 2761.

Method of Constructing Reinforced Concrete Pile Bents for the Atlantic City Boardwalk. Illustrates and describes the structural details and construction methods. 2500 w. Engng-Con—Feb. 17, 1909. No. 2538.

Reclamation.

The Reclamation of the Site for the Beach City of Naples, California. Explains conditions and the scheme of development of the site. Ills. 2000 w. Eng Rec—Feb. 6, 1909. No. 2311.

Record Systems.

Some of the Recording Systems of a Large Engineering Corporation. R. M. Henderson in the *Armour Engineer*. Explains methods of systemizing field work so as to enable the home office to keep constantly in touch with work everywhere. 2500 w. Eng Rec—Jan. 30, 1909. No. 2177.

We supply copies of these articles. See page 159.

The Filing System of the Elevated and Subway Construction Department, Boston Elevated Railway Company. Herbert C. Hartwell. Explains the working methods of the plan-filing system. 2000 w. Eng Rec—Feb. 6, 1909. No. 2306.

Reinforced Concrete.

Formulas for the Strength of Reinforced-Concrete Beams. Percy John Robinson. A discussion of formulae, developed on rational lines, by which the strength may be calculated. 3500 w. Inst of Civ Engrs—No. 3773. No. 2794 N.

Simplified Methods of Calculating Reinforced Concrete Beams. W. Noble Twelvetrees. Read before the Manchester Univ. Engng. Soc. A mathematical study, and a description of a calculating instrument devised by the author. 4000 w. Surveyor—Jan. 29, 1909. No. 2350 A.

A New Graphical Method for Calculating Beams of Varying Moment of Inertia and Fixed at Both Ends (Eine neue graphische Berechnungsmethode für beiderseits eingespannte Träger mit veränderlichem Trägheitsmoment). Rich.Wuczkowski. Mathematical. Ills. 2000 w. Beton u Eisen—Jan. 8, 1909. No. 2819 E.

Distribution of Stresses in Compound Bodies (Ueber die Spannungsverteilung in Verbundkörpern). Alfons Leon. A mathematical discussion illustrated by the case of reinforced concrete. Ills. Serial. 1st part. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 9, 1909. No. 2816 D.

The Joining of Tension Reinforcement in Concrete Beams (Expériences sur les Jonctions de Barres tendues dans les Poutres en Béton armé). M. Mesnager. Results of extensive tests on overlapping and joining bars for reinforcement. Ills. 11000 w. Ann d Ponts et Chauss—1908—II. No. 2607 E + F.

Advance in Reinforced-Concrete Construction: An Argument for Muitiple-Way Reinforcement in Floor Slabs. C. A. P. Turner. An illustrated article describing this system and the advantages claimed. 4500 w. Eng News—Feb. 18, 1909. No. 2522

The Cost of Concrete Construction as Applied to Buildings. Leonard C. Wason. Gives actual costs of various parts of building construction. 2500 w. Cement—Jan., 1909. No. 2727 C.

The Advantages of Reinforced Concrete for Railway Construction. B. H. Davis. Considers the familiar uses of this material in railway construction, pointing out the advantages and disadvantages, and comparing costs with other materials. Ills. 4500 w. Cement—Jan., 1909. No. 2725 C.

The Applicability and Economy of Concrete and Reinforced Concrete for Subway Construction Charles M. Mills. Abstract of paper read before the Nat. Assn. of Cement Users. Considers the important features and advantages. 2000 w. Engng-Con—Feb. 10, 1909. No. 2468.

A Reinforced Concrete Theater and Office Building, Los Angeles, Cal. Describes the peculiar heavy construction of this building, giving plans. 2000 w. Eng News—Feb. 11, 1909. No. 2393.

The Majestic Theater Building at Los Angeles. Illustrated description of a combined office and theater structure built entirely of reinforced concrete. 3000 w. Eng Rec—Jan. 30, 1909. No. 2179.

Reinforced-Concrete Building of the Phelps Publishing Co., Springfield, Mass. Arthur C. Tozzer. The design and construction of a large 8-story building is illustrated and described. 2500 w. Eng News—Feb. 18, 1909. No. 2520.

A Ten-Story Reinforced Concrete Warehouse in Pittsburg. Brief illustrated description. 1600 w. Eng Rec—Feb. 6, 1909. No. 2304.

Cold-Storage Warehouses of Reinforced Concrete Construction. J. P. H. Perry. Considers different methods of insulating buildings for cold storage and the adaptability of reinforced concrete to this type of structure. Ills. 4500 w. Eng Rec—Jan. 30, 1909. No. 2180.

The New Board Mill of the Androscoggin Pulp Company. Describes a new reinforced-concrete mill at South Windham, Maine, and its equipment. 2000 w. Eng Rec—Feb. 13, 1909. No. 2451.

Reinforced Concrete Stock Pen Construction for the Union Stock Yards & Transit Co., Chicago, Ill. The present article gives details of the new platform and pen construction. Ills. 1500 w. Engng Con—Feb. 17, 1909. No. 2537.

See also Coal Pockets, Contracts, Fireproof, Grain Elevators, Piling, and Retaining Walls, under CONSTRUCTION; and Coast Protection, under WATERWAYS AND HARBORS.

Retaining Walls.

Reinforced Concrete Retaining Wall at St. George, Staten Island. Louis L. Tribus. From a paper before the Munic. Engrs. of the City of N. Y. An illustrated description of the design and construction. 3500 w. Munic Engng—Feb., 1909. No. 2335 C.

Roofs.

The Use of Asphaltum. Harry Larkin. Information concerning the uses and proper management of asphaltum work, the need of intelligent application, etc. 4500 w. Jour Assn of Engng Socs—Dec., 1908. No. 2415 C.

Tin Roofs on Chemically Fireproofed Sheathing Boards. H. N. Taylor. Reports a case where contact of tin with fireproofed timber caused corrosion. 1200 w. Met Work—Jan. 30, 1909. No. 2171.

We supply copies of these articles. See page 159.

Specifications.

Suggestions for Drawing Specifications for Engineering Work. H. Laurence Butler. Read before the Civ. & Mech. Engng. Soc., Gt. Britain. Considers essential points of a specification that properly fulfils its purpose. 4500 w. Engng-Con—Feb. 3, 1909. No. 2297.

Steel.

The Philadelphia Opera House. Illustrated description of interesting details of a brick and steel structure and of the methods of erection. 3000 w. Eng Rec—Jan. 30, 1909. No. 2181.

Structural Details in the Farmers' Loan & Trust Building, New York. Illustrated description of wind bracing, cantilever girders, etc. 3000 w. Eng Rec—Feb. 20, 1909. No. 2564.

The Alaska Commercial Building, San Francisco. Illustrated description of a 12-story and basement building, designed to resist earthquakes and fire. Located where quicksand and difficult foundation conditions were encountered. 1800 w. Eng Rec—Feb. 6, 1909. No. 2310.

Tunnels.

The Report of the Coroner's Jury on the Chicago Tunnel Crib Disaster A report of the burning of the superstructure of a temporary crib over a working shaft of a new intake tunnel at Chicago. 2500 w. Eng News—Feb. 25, 1909. No. 2758.

New Intake Tunnel. G. W. Allen. Illustrated detailed description of the construction of a tunnel under Toronto Bay in connection with the Toronto water supply. 2000 w. Can Engr—Jan. 29, 1909. No. 2167.

The Cortlandt Street Tunnel Under the Hudson River; Meeting of Headings. A brief account of the junction, outlining the work. 800 w. Eng News—Feb. 4, 1909. No. 2276.

The Connection Between the Westerly Approach and the Subaqueous Sections of the Detroit River Tunnel. An illustrated description of the methods adopted. 2000 w. Eng Rec—Jan. 30, 1909. No. 2175.

Methods of Tunnel Work and Cost Data on an Irrigation Project. Henry A. Young. Describes work on the Huntley Project, Mont., giving cost data. 1500 w. Eng News—Feb. 4, 1909. No. 2277.

A New Twelve-Mile Italian Tunnel. Illustrated account of the proposed new tunnel between Genoa and Milan. 2500 w. Engr, Lond—Feb. 12, 1909. No. 2703 A.

Rapid Methods in Driving Alpine Tunnels. Walter I. Aims. Results of the writer's observations on a recent visit to the Loetschberg tunnel, Switzerland 1400 w. Compressed Air—Feb., 1909. No. 2412.

Problems in the Construction of Deep-Lying Alpine Tunnels and Experiences in Building the Simplon (Das Problem des Baues langer, tiefliegender Alpentunnels und die Erfahrungen beim Baue des Simplontunnels). Karl Brandau. A practical description of the solution of problems in the Simplon tunnel. Ills. Serial, 1st part. 2800 w. Schweiz Bau—Jan. 2, 1909. No. 2688 B.

MATERIALS OF CONSTRUCTION.

Reinforced Concrete.

Column Tests of Sachs & Pohlmann, Hamburg (Säulenversuche von M. Sachs & Pohlmann, Hamburg). Gives the results. Ills. Serial, 1st part. 2000 w. Beton u Eisen—Jan. 28, 1909. No. 2821 E.

Timber.

Woodwork. E. Guy Dawber. A lecture on the historical growth of design in woodwork. 1400 w. Archt, Lond—Feb. 5, 1909. Serial, 1st part. No. 2474 A.

Re-Afforestation. Editorial discussion of this question with special reference to the United Kingdom. 1700 w. Engng—Jan. 29, 1909. No. 2363 A.

MEASUREMENT.

Base Lines.

Determination of the Length of Geodetic Base Lines by Trigonometry (Trigonometrische Längenbestimmung geodatischer Grundlinien). A. Tichy. A complete demonstration of the methods. Ills. Serial, 1st part. 3300 w. Zeitschr d Oest Ing u Arch Ver—Jan. 1, 1909. No. 2611 D.

Concrete Testing.

See Testing Machines, under MEASUREMENT.

Surveying.

The Ordnance Survey. Sir Duncan Alexander Johnston. A brief historical sketch, describing how the cadastral survey of Great Britain was made, and showing how the maps are being revised. 3500 w. Surveyor—Feb. 12, 1909. Serial. 1st part. No. 2586 A.

Testing Machines.

A 250-Ton Hydraulic Compression Testing Machine. James L. Davis. Illustrated description of the machine for the New York Board of Water Supply for testing concrete in compression. 1000 w. Eng News—Feb. 11, 1909. No. 2398.

A Remarkable Testing Machine. Richard L. Humphrey. Describes the 10,000,000-pound hydraulic compression testing-machine for the testing laboratories of the U. S. Geological Survey. Ills. 800 w. Ir Age—Feb. 11, 1909. No. 2389.

MUNICIPAL.

Abattoirs.

Public Abattoirs. R. Stephan Ayling. Presents briefly the advantages and disadvantages of public slaughter-houses, and

the points to be observed in a well-planned abattoir, illustrating and describing examples in France, Germany and England. General discussion. 5500 w. Jour Roy Inst of Brit Archts—Jan. 23, 1909. No. 2498 C.

Municipal Engineering.

Inaugural Address of the President. Edward John Silcock. Introductory remarks, followed by a review of matters relating to municipal engineering. 10500 w. Soc of Engrs—Feb. 1, 1909. No. 2713 N.

Pavements.

Street Pavements. George C. Powell. Gives details regarding pavements suitable for city traffic. Ills. 2500 w. Can Engr—Jan. 29, 1909. No. 2169.

Creosoted Wood Block Pavements. Abstracts of two papers on this subject before the convention of the Illinois Soc. of Engrs. & Surveyors. 2500 w. Eng News—Feb. 18, 1909. No. 2521.

Mosaic Pavements (Pavimenti e Rivestimenti a Mosaico). Discusses pavements of artificial stone, the manufacture of the blocks, construction of the pavement, etc. Ills. Serial. 1st part. 2500 w. Il Cemento—Jan. 15, 1909. No. 2653 D.

Refuse Disposal.

Garbage Incineration in Scranton. Describes two incinerators recently completed, the new system of garbage collection, giving cost of operation. 2200 w. Munic Jour & Engr—Feb 3, 1909. No. 2234.

The Garbage Crematory of the Newport Naval Training Station. R. E. Bakenhus. Illustrates and describes this successful plant at Newport, R. I. 2500 w. Eng Rec—Feb. 20, 1909. No. 2569.

Roads.

Road Construction and Maintenance. R. E. B. Crompton. Claims that it is now possible to build dustless roads at no greater cost than for ordinary roads. 2500 w. Autocar—Jan. 30, 1909. No. 2340 A.

Road Management and Repair. John H. Evans. Read before the Inst. of Munic. Engrs. Explains the methods adopted in the county of Hertfordshire and which have been carried out with success both in cost and results. Discussion. 5500 w. Surveyor—Jan. 22, 1909. No. 2209 A.

Comparative Maintenance Costs of Macadam and Paved Roads (Comparaison du Pavage et de l'Empierrement au Point de Vue du Prix de Revient annuel). H. Heude. A comparison of annual costs including depreciation charges. 2800 w. Ann d Ponts et Chauss—1908-V. No. 2610 E + F.

Methods of Preventing Damage to Road Surfaces by High Speed Motor Cars. From a report by Nelson P. Lewis to the Board of Estimate and Apportionment of New York City. 3500 w. Engng-Con—Feb. 10, 1909. No. 2469.

Road Building by the United States in Cuba. William Atherton Du Puy. An account of the macadamized roads built under the *régime* of the provisional governor, Charles E. Magoon. Ills. 1800 w. Sci Am—Feb. 13, 1909. No. 2401.

The Road Congress (Le Congrès de la Route). A. Loreau. A report of the proceedings of the International Highway Congress with the text of the resolutions and conclusions. 7000 w. Mem Soc Ing Civ de France—Nov., 1908. No. 2601 G.

The First International Highway Congres (Le premier Congrès international de la Route.) M. Le Gavrian. A review of the proceedings and the work accomplished. 11000 w. Ann d Ponts et Chauss—1908-V. No. 2609 E + F.

Sewage Disposal.

The Sewage Problem Popularly Stated. Clark P. Collins. Brief description and comparison of the methods of sewage disposal commonly practiced. 4000 w. Sci Am Sup—Feb. 20, 1909. No. 2530.

An Introduction to Sewage Purification Problems (Einführung in die Frage der Abwasserreinigung). A. Lübbert. A general review of present practice. Serial. 1st part. 5800 w. Zeitschr d Ver Deutscher Ing—Jan. 2, 1909. No. 2835 D.

The Hampton Doctrine. Dr. A. Lübbert. A discussion of a paper by W. Owen Travis on "The Hampton Doctrine in Relation to Sewage Purification." Serial. 1st part. 2200 w. Gesundheits-Ing—Jan. 2, 1909. No. 2805 D.

Percolation Beds for Sewage Treatment. William Clifford. Paper before the Inst. of Civ. Engrs. A report of investigations of the physical conditions accompanying purification. 4000 w. Eng Rec—Feb. 6, 1909. No. 2305.

Sewage Purification by the "Oxychlorides" Process. Editorial review of Dr. S. Rideal's paper on the "Application of Electrolytic Chlorine to Sewage Purification and Deodorization by the "Oxychlorides" Process, read before the Faraday Society. 2000 w. Engng—Feb. 12, 1909. No. 2507 A.

The Use of Peat in the Construction of Biological Sewage Purification Plants (Ueber die Verwendbarkeit von Torf zum Aufbau von biologischen Abwasserreinigungsanlagen). Joseph Ghysen. A discussion of its value as a purifying agent. Ills. 4000 w. Gesundheits-Ing—Jan. 2, 1909. No. 2804 D.

The Theory of Sedimentation and the Grimm Purification System (Zur Theorie der Sedimentierung und die Grimmsche Flachbecken-Kläranlage). A. Lübbert. Describes and discusses the Grimm system. Ills. 2400 w. Gesundheits-Ing—Jan. 30, 1909. No. 2610 D.

Sewage and Its Distribution (Ueber Abwassermengen und deren zeitliche Ver-

teilung in Strassenkanälen). Otto Schubert. A note on the determination of the size of purification plants. Plates. 2000 w. Gesundheits-Ing—Jan. 30, 1909. No. 2608 D.

The Unna Biological Purification Plant (Die biologische Kläranlage der Stadt Unna). C. Modersohn. Describes the construction and operation of a plant to serve a city of 11,000 inhabitants. Ills. 3800 w. Gesundheits-Ing—Jan. 23, 1909. No. 2807 D.

Sewage Disposal at Birmingham, England. An account taken from an official report by E. J. Fort. 2500 w. Eng Rec—Feb. 6, 1909. No. 2309.

Sewer Gauging.

Some Sewer Gaugings. Delmar E. Teed. Read before the Mich. Engng. Soc. Explains methods used to measure the daily discharge of the sewers, and the data obtained. Ills. 1700 w. Munic Engng—Feb., 1909. No. 2334 C.

Sewers.

Recent Improvements of Stony Brook, Boston. Illustrated description of work under supervision of the sewer department, and of the interesting features of the contractor's plant. 2800 w. Eng Rec—Feb. 6, 1909. No. 2308.

Construction of a Concrete Block Sewer in Toledo, Ohio. Frank I. Consaul. Illustrated description of the work and local conditions. 1000 w. Eng News—Feb. 4, 1909. No. 2273.

Glasgow South-Side Sewage Outfall Works. Illustrates and describes some details of works under construction. 1500 w. Engr, Lond—Feb. 5, 1909. No. 2493 A.

WATER SUPPLY.

Backwater.

New Methods in Backwater Computations. B. F. Groat. Explains the application of a new formula for stream flow to the problem, and also mechanical and graphical methods for ascertaining areas of cross-sections for various degrees of backwater. 2500 w. Minn Engr—Jan., 1909. No. 2730 C.

Barrages.

The Esneh Barrage for Irrigation in Egypt. Briefly reviews the scheme of irrigation in the Nile valley, giving illustrated description of the barrage across the Nile at Esneh. Plates. 6800 w. Engng—Feb. 5, 1909. No. 2486 A.

The Esneh Barrage. Photographs, drawings and description of work in Egypt designed to hold up the low floods on the Nile. Plate. 3000 w. Engr, Lond—Jan. 22, 1909. No. 2221 A.

Dams.

The Core Wall in a River Wing Dam at Moline, Ill. Illustrates and describes the construction of a core wall to meet conditions quite out of the ordinary. 2000 w. Eng Rec—Feb. 6, 1909. No. 2307.

The Improvement of the Charles River at Boston, Mass. Edward C. Sherman. An interesting illustrated account of the construction of the Charles River dam and basin, and related improvements. 1800 w. Sci Am—Feb. 6, 1909. No. 2281.

See also Barrages, under WATER SUPPLY.

Filtration.

The Filtration and Purification of Water for Public Supply. John Don. Abstract of a paper selected for the first award of the "Water Arbitration Prize," 1908. Discusses the sources of supply, impounding, filtration, and distribution. Ills. 8000 w. Inst Mech Engrs—Jan. 15, 1909. No. 2200 N.

Ground Waters.

A Phase of Ground Water Problems in the West. W. C. Mendenhall. A study of the ground waters in arid or semi-arid regions. Map. 3800 w. Ec-Geol—Jan.-Feb., 1909. No. 2717 D.

Illinois.

Chemical and Biological Survey of the Waters of Illinois. Edward Bartow. A report of the work of the State Water Survey from Sept. 1, 1906, to Dec. 31, 1907, giving detailed description of the work accomplished. Ills. 19000 w. Univ. of Ill Bul—Sept. 22, 1908. No. 2418 N.

Irrigation.

Irrigation Works in India: New Projects in the Presidency of Madras. Percy F. Martin. Information concerning the Bhavani project, the Tungabhadra scheme, and the Kistna reservoir project. 3500 w. Engr, Lond—Jan. 29, 1909. No. 2370 A.

Irrigation in the Lerma Valley (Irrigasión en el Valle de Lerma). Carlos Wauters. A preliminary report on irrigation problems in this district in Argentina. 13500 w. Anales d l Soc Cien Argentina—Sept., 1908. No. 2656 E + F.

See also Tunnels, under CONSTRUCTION; and Barrages, under WATER SUPPLY.

Meters.

The Sale of Potable Waters in Cities (La Vente de l'Eau potable dans les Villes). P. Juppont. Discusses the economics of water supply, the use of meters and the efficiency of the various types. 5500 w. Génie Civil—Jan. 23, 1909. No. 2644 D.

New York State.

Report of the New York State Water Supply Commission. A review of the report for the year ending Feb. 1, 1909, with editorial. 8000 w. Eng News—Feb. 18, 1909. No. 2525.

See also Water Powers, under WATERWAYS AND HARBORS.

Purification.

The Iron Removal Plant of the Shelby,

Ohio, Water Company. Philip Burgess. Report of an examination made of this plant. 3500 w. Eng Rec—Feb. 20, 1909. No. 2566.

The Electrical Conductivity of Water (Ueber die elektrische Leitfähigkeit natürlicher Wässer). H. Stooff. Discusses how it may be taken advantage of for purification purposes. Ills. 5200 w. Gesundheits-Ing—Jan. 30, 1909. No. 2609 D.

See also Filtration, under WATER SUPPLY.

San Francisco.

San Francisco's Efforts to Obtain Municipal Ownership of Its Water Supply. Explains matters relating to the Hetch-Hetchy Valley controversy. Also editorial and letters. Ills. 15000 w. Eng News—Feb. 4, 1909. No. 2279.

Discussion of Paper by C. E. Grunsky, "The Water Supply of San Francisco, Cal." 6500 w. Jour Assn of Engng Socs—Dec., 1908. No. 2416 C.

Sluice Gates.

The Cast-Iron Sluice Gates for the Fens Gate Chamber, Charles River Basin, Boston, Mass. Walton H. Sears. Illustrated description. 800 w. Eng News—Feb. 25, 1909. No. 2760.

Recent Sluice Design (Neue Schützenkonstruktionen). A. Bühler. Illustrates and discusses mathematically two recent designs. 2000 w. Schweiz Bau—Jan. 30, 1909. No. 2693 B.

Tunnels.

See same title, under CONSTRUCTION.

Typhoid.

A Notable Typhoid Epidemic at Mankato, Minn. F. H. Bass. An account of an epidemic where the artesian water supply was supposed to make contamination impossible. Maps. 1200 w. Eng News—Feb. 11, 1909. No. 2396.

Water Works.

See Concrete, under CONSTRUCTION.

Wells.

A Few Examples of Double Wells. F. G. Clapp. Describes wells where two distinct types of water can be obtained from one well; one well gives fresh and also salt water; another fresh and sulphur water. 1500 w. Eng Rec—Feb. 20, 1909. No. 2567.

WATERWAYS AND HARBORS.

Baltimore.

New Harbor Works at Baltimore. Illustrated detailed description of the work of reconstruction since the fire. 2000 w. Engr, Lond—Jan. 29, 1909. No. 2367 A.

Bridge Piers.

The Damming Effect of Bridge Piers in Waterways (Einige Untersuchungen im Staugebiete eines Wasserlaufs bei Brückeneinbauten). W. Plenkner. A mathematical discussion. Ills. 5500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 2, 1909. No. 2814 D.

Chicago.

Report to the Chicago Harbor Commission on Obstacles to Chicago's Water Shipping Development. Abstract of report by George C. Sikes. 8000 w. Marine Rev—Jan. 28, 1909. Serial. 1st part. No. 2164.

Coast Protection.

The Execution of Coast Protection Works in Reinforced Concrete (Die Ausführung von Seesenkwerken aus Eisenbeton). Robert de Muralt. Describes the author's system. Ills. Serial. 1st part. 1800 w. Beton u Eisen—Jan. 8, 1909. No. 2820 E.

Drydocks.

The Great Drydock at Pearl Harbor, Hawaii. Elmer Murphy. Describes this drydock, which is the largest ever constructed by the U. S. Navy Department. 1000 w. Sci Am—Feb. 6, 1909. No. 2283.

France.

The Great Deficiency in the Inland Waterways System of France (Les grandes Lacunes du Réseau navigable de la France). F. Arnodin. Compares water with rail transport and shows the importance of canal competition. 3500 w. Génie Civil—Jan. 30, 1909. No. 2646 D.

Georgian Bay Canal.

Description and Cost Estimates of the Proposed Georgian Bay Ship Canal. Maps, sections and description as given in an "interim report" of the project. 3000 w. Eng News—Feb. 25, 1909. No. 2754.

Kanawha River.

A Defence of the Present System of Improvements on the Kanawha River. F. W. Altstaetter. Gives results of a study of this watershed, showing that reservoir regulation would have been very costly and accomplished nothing more than the existing improvements. Editorial. 7500 w. Eng Rec—Feb. 13, 1909. No. 2447.

Levees.

The McGee Creek Levee and Drainage District of Pike and Brown Counties, Illinois. A. H. Bell. Read before the Ill. Soc. of Engrs. & Surv. Describes the construction of works for protection from overflows and for drainage of the land. 1200 w. Eng Rec—Feb. 20, 1909. No. 2570.

Locks.

The Lock in the Mississippi River at Moline, Ill. Illustrated description of the lock and its construction, explaining conditions. 3000 w. Eng Rec—Jan. 30, 1909. No. 2178.

The Floride Lock at Havre (Note sur les Travaux de Construction de l'Ecluse à

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Sas de la Floride au Port du Havre). M. Guiffart. Illustrated detailed description of the construction of this important part of the harbor-improvement work. 30000 w. Ann d Ponts et Chauss—1908-V, No. 2608 E + F.

Milan.

A Project for a New Port at Milan (Il Progetto del nuovo Porto di Milano). A discussion of the project, the difficulties and problems to be solved. Ills. 4000 w. Monit Tech—Dec. 30, 1908. No. 2649 D.

Panama Canal.

A Sea-Level Canal at Panama—A Study of Its Desirability and Feasibility. Henry G. Granger. Advocates a reconsideration of the subject, in the light of new facts, and emphasizes the objections to a lock canal, and presents an outline of a construction that the writer favors. 11500 w. Bul Am Inst of Min Engrs—Jan., 1909. No. 2421 F.

The Report of the Board of Engineers on the Panama Canal Work. Report with president's letter, records of engineers forming the advisory board, and editorial discussion. 12000 w. Eng News—Feb. 25, 1909. No. 2757.

Present Conditions in the Panama Canal Zone. A favorable account, with illustrations. 2200 w. Sci Am—Feb. 6, 1909. No. 2284.

The Construction of the Panama Canal (Die Arbeiten am Panama-Kanal). Hermann Bertschinger. A general review of the project and the work already accomplished. Ills. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1909. No. 2840 D.

River Improvement.

The Progress of River Improvements in the Vicinity of Pittsburg. J. W. Arras. An illustrated account of work in the Allegheny, Monongahela and Ohio rivers for the improvement of navigation. 3500 w. Marine Rev—Feb. 4, 1909. Serial. 1st part. No. 2314.

See also Kanawha River, under WATER SUPPLY.

River Regulation.

River Control by Wire Net-Work. Francis Philip Anderson. Explains conditions on the Bengal Dooars railway, describing this wire network device and its uses in the endeavor to control the streams bridged. Ills. 4000 w. Inst of Civ Engrs—No. 3748. No. 2702 N.

River Regulation in Bohemia (Landeskommission für Flussregulierungen im Königreiche Böhmen). Hugo Franz. Reviews the work of the Government Commission during 1906 and 1907. Ills. Serial. 1st part. 5000 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 30, 1909. No. 2818 D.

Rock Removal.

A New Sub-Aqueous Rock-Breaking Machine with Chisel Acting in Air Chamber. Barton H. Coffey. Illustrated description of the machine, and report of work in Boston Harbor. 1500 w. Eng News—Feb. 4, 1909. No. 2274.

Toronto.

Toronto Harbor. W. J. Fuller. Reviews some of the engineering problems which have arisen from time to time in regard to the harbor and the improvements undertaken. 8500 w. Can Engr—Jan. 29, 1909. No. 2168.

U. S. Waterways.

Duty of Congress as to National Waterways. Albert H. Scherzer. Urging the development of transportation by water in the United States. 2800 w. Mfrs Rec—Feb. 25, 1909. No. 2743.

The Eastern Link in the Great Atlantic Coast Inland Waterway. James C. Sanford. Read at Inland Waterways Conference. A brief description of the engineering features on the proposed canal to connect Narragansett Bay and Boston Harbor. 2500 w. Naut Gaz—Feb. 4, 1909. Serial. 1st part. No. 2286.

The Control of Hydraulic Power Development in New York. Abstract of the recent report of the State Water Supply Commission, with editorial. 7000 w. Eng Rec—Feb. 13, 1909. No. 2452.

Connecticut River for Electric Power. Alton D. Adams. Discusses the power that may be developed for purpose of electric transmission. 2000 w. Elec Rev, N Y—Feb. 13, 1909. No. 2462.

Water Power Development in the Pacific Northwest. Louis P. Zimmerman. Information regarding the immense water power available and as yet largely undeveloped, especially in Washington. 2500 w. Minn Engr—Jan., 1909. No. 2731 C.

The White Coal of Sweden. John George Leigh. An illustrated study of the development of the abundant hydraulic power of Scandinavia. 7000 w. Cassier's Mag—Feb., 1909. No. 2326 B.

MISCELLANY.

Earthquakes.

Earthquake Forecasts. G. K. Gilbert. Abstract of address to the Am. Assn. of Geog. Discusses the possibility of scientific forecast, and the duty of architects and engineers to study the danger factor in connection with construction in earthquake regions. 3500 w. Min & Sci Pr—Jan. 30, 1909. No. 2290.

Geology.

The Principles of Engineering Geology. Herbert Lapworth. Lectures to students demonstrating the close relationship of civil engineering and geology. Ills. 10500 w. Inst of Civ Engrs. No. 2709 N.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Inductance Coils Used in Wireless Telegraphy. John L. Hogan, Jr. Illustrates and describes different types of construction in variable induction coils and their alvantages. 2000 w. Elec Wld—Feb. 18, 1909. No. 2519.

Wireless Telegraphy (La Telegrafia inalámbrica). E. Guarini. A discussion of its past, present and future and application in countries like Peru. Ills. Serial. 1st part. 3000 w. Anales d l Soc Cien Argentina—Aug., 1908. No. 2655 E + F.

Radio-Telephony.

A New System of Wireless Telephony. A. Carletti. Illustrated description of experimental work by Prof. Quirius Majorana, and the system that has made possible intercommunication over a distance of 312 miles. 1200 w. Elect'n, Lond—Jan. 29, 1909. No. 2347 A.

Wireless Telephony (Drahtlose Telephonie vermittels elektrischer Schwingungen). Gustav Eichhorn. A review of the fundamental principles and present developments. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 23, 1909. No. 2817 D.

Telephone Lines.

New Types of Pupin Coils for Overhead Lines (Neue Typen der Pupinschen Freileitungsspule). Robert Nowotny. Illustrates and describes the apparatus and its installation. 2700 w. Elektrotech u Maschinenbau—Jan. 3, 1909. No. 2826 D

Telephotography.

Korn's Apparatus for Photographic Transmission. Louis Dubois. Illustrated detailed description. 1800 w. Elect'n, Lond—Jan. 22, 1909. Serial. 1st part. No. 2207 A.

Tele-Stereography.

Note on the Tele-Stereograph (Note sur le Télé-Stéréographe). M. E. Belin. Illustrated description of an apparatus for the telegraphic reproduction of any document containing lines in relief however slight. 2000 w. Bul Soc d'Encour—Dec., 1908. No. 2622 G.

DISTRIBUTION.

Current Rectifiers.

Solid Rectifiers. Greenleaf W. Pickard. Reviews the work of other investigators and the writer's study of the action of contacts of small arcs between dissimilar conductors. 4000 w. Elec Rev, N Y—Feb. 20, 1909. No. 2555.

Regulations.

Factory and Workshop Act, 1901.—Rules for Electricity in Factories and Workshops. A copy of revised regulations as given in the report of Mr. James Swinburne. 5500 w. Elec Engr, Lond—Jan. 22, 1909. No. 2203 A.

Switches.

Electric Switches. W. B. Kouwenhoven. Explains various kinds of electric switches and the important factors that enter into their design. Ills. 2000 w. Ry & Loc Engng—Feb., 1909. No. 2267 C.

See also Transformers, under TRANSMISSION.

Wiring.

The Wiring of Buildings. D. S. Munro. Abstract of paper read before the Glasgow Soc. of the Inst. of Elec. Engrs. Reviews the various methods of wiring in proof that no really good and cheap method has yet been invented. 1400 w. Elect'n, Lond—Jan. 29, 1909. No. 2348 A.

Conduit Wiring. L. M. Waterhouse. Deals with some points in conduit wiring installations, and the materials required. Short discussion. 8500 w. Elec Engr, Lond—Jan. 22, 1909. No. 2201 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Parallel Operation of Alternators. Dr. E. Rosenberg. Read before the Manchester Sec. of Inst. of Elec. Engrs. A study of the problem from the theoretical point of view, and showing how the results may be employed. 5500 w. Elec Engr, Lond—Jan. 29, 1909. Serial. 1st part. No. 2343 A.

Induced Pressures in the Exciting Winding of Single-Phase Dynamos (Betrachtungen über die in der Erregerwicklung von Einphasengeneratoren induzierten Spannungen). H. Brühn. A mathematical discussion. Ills. 2500 w. Elektrotech u Maschinenbau—Jan. 3, 1909. No. 2825 D.

Brushes.

The Mechanics of Brushes (Beiträge zur Mechanik der Bürsten). C. Richter. A discussion of the theoretical mechanics of brushes sliding on a commutator, the conditions of equilibrium, etc. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—Jan. 10, 1909. No. 2828 D.

Commutators.

Turning and Grinding Commutators. W. Burns. Directions for the work. 2000 w. Elec Wld.—Feb., 1909. No. 2270.

Controllers.

Application of Automatic Controllers to Direct-Current Motors. D. E. Carpenter. Outlines some of the applications to spe

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cific services. The present article deals with elevator control. Ills. 1700 w. Elec Jour—Feb., 1909. Serial. 1st part. No. 2739.

D. C. Dynamos.

The D. C. Transverse-Field Dynamo and Its Applications (Die Gleichstrom-Querfeldmaschine und ihre Anwendungen). Richard Neumann. Discusses particularly its application to electric train lighting. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 1909. No. 2839 D.

D. C. Motors.

The Installation of Direct-Current Motors. R. H. Fenkhausen. Gives directions for setting up and operating motors, with some general rules. Ills. 2500 w. Power—Feb. 9, 1909. No. 2377.

See also Controllers, under DYNAMOS AND MOTORS.

Heating.

Determination of the Time Constant and the Stationary Temperature of Electrical Machines (Die Ermittelung der Zeitkonstante und der stationären Temperatur elektrischer Maschinen). Gustav Benischke. Mathematical discussion of heating and cooling problems. Ills. 2000 w. Elektrotech u Maschinenbau—Jan. 10, 1909. No. 2827 D.

ELECTRO-CHEMISTRY.

Corrosion.

The Corrosion of Iron and Steel. Alfred Sang. A study of the nature of corrosion, examining the theories advanced, and the relation of structure, stress, modern conditions, air, water, the electric current, etc., and the best means of protection. General discussion. 22000 w. Pro Engrs' Soc of W Penn—Jan., 1909. No. 2747 D.

The Corrosion of Iron. Abstract of a paper by Dr. William H. Walker on the "Corrosion of Iron and Steel and Modern Methods of Preventing It." 2800 w. Eng Rec—Feb. 20, 1909. No. 2571.

Electro-Metallography.

See Refining, under MINING AND METALLURGY, COPPER; Electro-Metallurgy, under MINING AND METALLURGY, IRON AND STEEL; and Zinc Recovery, under MINING AND METALLURGY, LEAD AND ZINC.

Electroplating.

Automatic Electroplating by Means of the Broderick Machine. Illustrated description of this plating machine and its operation. 1000 w. Brass Wld—Feb., 1909. No. 2722.

Modern Methods for the Electrodeposition of Zinc, Copper, Nickel and Brass. Louis Potthoff. Illustrates and describes automatic devices for the economical handling of material. 800 w. Brass Wld—Feb., 1909. No. 2724.

Nitrogen.

Atmospheric Nitric Acid and Nitrates. Reviews briefly the attempts made for the commercial fixation of atmospheric nitrogen, specially describing the system of Mr. Moscicki. 1600 w. Elec Engr, Lond—Jan. 29, 1909. No. 2344 A.

ELECTRO-PHYSICS.

Electrons.

What Is the Electron Theory? Prof. L. Graetz, in *Umschau*. A simple and clear explanation. 2500 w. Sci Am Sup—Feb. 13, 1909. No. 2402.

Oscillations.

Complex Calculation of Oscillation Problems (Die komplexe Rechnung bei Schwingungen). Fritz Emde. A discussion of the use of complex quantities in the treatment of the theory of oscillations. Ills. Serial. 1st part. 3000 w., Elektrotech u Maschinenbau—Jan. 24, 1909. No. 2830 D.

Radioactivity.

Radioactive Substances (Ueber radioaktive Substanzen). Stephan Meyer. A review of present knowledge of radioactivity, particularly the recent discoveries. Ills. Serial. 1st part. 2000 w. Zeitschr d Oest Ing u Arch Ver—Jan. 8, 1909. No. 2813 D.

Radioactive Transformations and Transmutations (Transformations radioactives et Transmutations). Jacques Danne. A review of recent advances and present knowledge. Ills. Serial. 1st part. 4800 w. Génie Civil—Jan. 2, 1909. No. 2636 D.

GENERATING STATIONS.

Central Stations.

The Use of Large Gas Engines for Generating Electric Power. Leonard Andrews and Reginald Porter. Estimates the respective capital costs of a steam turbine and a gas engine central station for the same load, and shows what the running costs would be. Ills. 12000 w. Inst of Elec Engrs—Feb. 11, 1909. No. 2579 N.

A 60-Cycle Gas-Driven Power Station. J. R. Bibbins. A report of operating results at the plant of the Union Switch & Signal Co. Ills. 3300 w. Elec Jour—Feb., 1909. No. 2738.

Operating Results from a Sixty-Cycle Gas-Driven Power Station. J. R. Bibbins. Gives actual experience and results at the Swissvale, Pa., plant. 4500 w. Elec Rev, N Y—Feb. 13, 1909. No. 2463.

Power Plant Extensions of the Boston Elevated Railway Company. Illustrates and describes the enlargement of the power plants and reconstruction work. 2500 w. Elec Wld—Feb. 18, 1909. No. 2517.

A New Lighting Station for Brockton. E. T. Reed. Illustrated description of a modern alternating-current turbine plant. 2500 w. Power—Feb. 16, 1909. No. 2499.

We supply copies of these articles. See page 159.

Electric Power Installation at Khartoum. Illustrated description of a large modern electric plant recently erected. 3000 w. Engng—Feb. 12, 1909. No. 2594 A.

Electric Power Plant at the Gouley Mine of the Eschweil Mining Company (Elektrische Kraftverteilungsanlage auf Grube Gouley des Eschweiler Bergwerksvereins). L. Haas. Illustrated detailed description. Serial. 1st part. 2100 w. Elek Kraft u Bahnen—Jan. 4, 1909. No. 2822 D.

Costs.

Power Costs in a 5000-Kilowatt Central Station. H. S. Knowlton. Gives the record of four years' cost of power in a New England central station. 1000 w. Power—Feb. 9, 1909. No. 2382.

Design.

Prime Movers. Charles P. Steinmetz. Discusses the features of prime movers and the suitability of different types for the requirements of electric service. 5500 w. Pro Am Inst of Elec Engrs—Feb., 1909. No. 2419 F.

Germany.

German Central Stations. Notes taken from *La Lumière Electrique*. Information showing the growth of the German electrical industry and related subjects. 1500 w. Elect'n, Lond—Jan. 29, 1909. No. 2346 A.

Hydro-Electric.

A Low-Head Hydroelectric Development. S. Rice. An interesting plant at Milford, Me., to develop 12,000 h. p. under a head of 20 feet, is described. Ills. 2200 w. Power—Feb. 9, 1909. No. 2374.

Italian Power Plants as Seen Through American Eyes. S. Q. Hayes. Describes features of interest in the Brusio plant observed by writer. Ills. 3500 w. Elec Jour—Feb., 1909. No. 2736.

Generating and Transmission Plants of the Società Angelo-Romana (Le Officine e gli Impianti elettrici per il Trasporto di Forza della "Società Angelo-Romana"). Illustrated detailed description. Power is generated at Tivoli and transmitted to Rome. Serial. 1st part. 2700 w. Industria —Jan. 3, 1909. No. 2651 D.

The la Vis Hydro-Electric Plant at Madières (Usine hydro-électrique de la Vis à Madières, Hérault). Michel Berthon. Illustrated detailed description of a 5,000 horse-power plant. 5000 w. Génie Civil—Jan. 23, 1909. No. 2643 D.

The New Tokio Hydro-Electric Plant at Katsuragawa (Das neue, bei Katsuragawa errichtete Elektrizitätswerk der Stadt Tokio). F. Dr...ler. Illustrated description. 2100 w. Die Turbine—Jan. 5, 1909. No. 2698 D.

See also Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Isolated Plants.

Isolated Power Plants. Richard W. Hale. A reply to C. M. Ripley's article, presenting the case for the central station. 3000 w. Ir Age—Feb. 18, 1909. No. 2508.

Residence Electric Lighting Plants. John Howatt. Brief consideration of plants for suburban or rural residences and their requirements. 1600 w. Minn Engr—Jan., 1909. No. 2732 C.

Power Plant of the Heath & Milligan Paint Works, Chicago. Illustrated description of a central plant for furnishing heat, light and power to various buildings. 2500 w. Eng Rec—Feb. 20, 1909. No. 2562.

The Power Plant of the Hoboken Passenger Terminal of the Lackawanna Railroad. Plans and detailed description of the new central station built for lighting, heating and power for this terminal. 3000 w. Eng Rec—Feb. 13, 1909. No. 2450.

Power Factor.

The Improvement of Power Factor in Alternating Current Systems. Miles Walker. Read before the Manchester Sec. of Inst. of Elec. Engrs. Discusses the improvement by using synchronous motors, capacity, and improving the induction motor, and describes a new tyne of machine, termed a "phase advancer." Ills. 4000 w. Elec Engr, Lond—Jan. 22, 1909. No. 2202 A.

Rates.

Electric Power Supply Tariffs. Stuart A. Russell. Urges the more careful investigation of the cost of generating and transmitting the power. 1500 w. Elec Rev, Lond—Jan. 22, 1909. No. 2204 A.

LIGHTING.

Illumination.

The Practical Solution of Lighting Problems (Les Solutions actuelles du Problème de l'Eclairage). H. Vigneron. A general discussion of the problems of illumination. Ills. Serial, 1st part. 2000 w. Tech Mod—Dec., 1908. No. 2632 D.

Incandescent Lamps.

Metallic-Filament Lamps. W. H. F. Murdock. Discusses their use on alternating current supply. 1000 w. Elec Rev, Lond—Jan. 22, 1909. No. 2205 A.

High-Efficiency Lamp Renewal. J. F. Musselman, Jr. Compares the metallic-filament incandescent lamp with the carbon-filament type, from a standpoint of cost of energy and renewal. 1000 w. Elec Wld—Feb. 11, 1909. No. 2392.

Street.

Street Lighting in the Smaller Urban Districts. Edgar F. Willson. Read before the Inst. of Munic. Engrs. Discussion. 4500 w. Surveyor. Feb. 12, 1909. No. 2587 A.

Street Lighting in Rio de Janeiro. A. H. Keleher. An illustrated article de-

scribing the lighting of important thoroughfares. 1200 w. Elec Wld—Feb. 11, 1909. No. 2390.

MEASUREMENT.

Dynamo Testing.

The Kapp-Hopkinson Test on a Single Direct-Current Machine. Dr. W. Lulofs. Shows how the Kapp-Hopkinson test may be adapted for a single lapwound, direct-current machine, provided it is not supplied with Mordey equalizing connections. 1200 w. Elect'n, Lond—Feb. 12, 1909. No. 2582 A.

Units.

A Note on Mechanical and Electrical Units (Note sur les Unités mécaniques et électriques). A discussion of the various systems. Serial, 1st part. 2000 w. L'Elec'n—Jan. 23, 1909. No. 2631 D.

Some Reflections on Systems of Units (Quelques Reflexions sur les Systèmes de Mesure). M. Brylinski. Compares the metric and C. G. S. systems showing that the latter is simply a modification of the former. Discussion. 8400 w. Bul Soc Int d'Elecns—Jan., 1909. No. 2613 F.

The Actual Situation of the Metric System (La Situation actuelle du Système métrique). Ch.-Ed. Guillaume. A discussion of the laws defining the fundamental metric units. 5200 w. Bul Soc Int d'Elecns—Jan., 1909. No. 2614 F.

POWER APPLICATION.

Heating.

Electric Heating. W. S. Hadaway, Jr. Considers the practical adaptability of commercial electricity for heating purposes and for performing useful work. Also discussion. 10500 w. Pro Am Inst of Elec Engrs—Feb., 1909. No. 2420 F.

Pumping.

See Electric Pumping, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

TRANSMISSION.

Cables.

Self-Induction of Three-Phase Cables. F. J. O. Howe. Gives tabulated tests and method of calculation. 1000 w. Elect'n, Lond—Feb. 12, 1909. No. 2584 A.

Line Design.

The Tension in Transmission-Line Wires (Sul Calcolo delle grandi Tesate delle Linee di Transmissione di Energia elettrica). Diofebo Negrotti. Mathematical discussion of long-span lines. Ills. 3000 w. Monit Tech—Jan. 10, 1909. No. 2650 D.

Lines.

The 110,000 Volt Transmission Line of the Grand Rapids Muskegon Power Company. Features of interest are illustrated and described. 500 w. Cent Sta—Feb. 1909. No. 2384.

Poles.

Poles for Power Transmission. An illustrated report of tests made in England of wooden poles for transmission lines. 1800 w. Sci Am Sup—Feb. 13, 1909. No. 2404.

How Bent Iron Side Poles Were Made Straight Without Removal in San Francisco. S. L. Foster. Brief illustrated description of method used to straighten poles after the fire. 600 w. Elec Rv Jour—Feb. 6, 1909. No. 2287.

Protective Devices.

Free Oscillations in Long Lines (Freie Schwingungen in langen Leitungen). Iwan Dörg. Discusses the use of condensers to protect the line against sudden dangerous rises of voltage. Ills. Serial. 1st part. 4500 w. Elektrotech u Maschinenbau—Jan. 31, 1909. No. 2831 D.

Rotary Converters.

The Practical Operation of Rotary Converters (Instructions pratiques sur la Conduite des Commutatrices). J. A. Montpellier. The first part of the serial discusses starting. Ills. Serial. 1st part. 1800 w. L'Elecn—Jan. 16, 1909. No. 2630 D.

Sub-stations.

Sub-Stations. H. B. Gear and P. F. Williams. The design, equipment and management of sub-stations to secure economy of operation. Ills. 6500 w. Elec Age—Feb., 1909. No. 2509.

Transformer Substation for Niagara Energy at Rochester, N. Y. Brief illustrated description. 1500 w. Elec Wld—Feb. 18, 1909. No. 2516.

Transformers.

Comparative Tests of Transformers. A. C. Scott. Gives results of a comparison of the performances of one-kilowatt units of certain commercial lines of transformers. 2000 w. Elec Wld—Feb. 4, 1909. No. 2269.

Transformer Sets for Variable Voltage Electric Furnace Requirements. C. I. Zimmerman. Describes two methods of obtaining variable voltages when currents as high as 40,000 or more amperes are needed. 3000 w. Wis Engr—Dec., 1908. No. 2734 D.

4450 Kilovolt-Ampere Transformers for Electrochemical Work (Transformatoren von 4450 KVA für elektrochemische Zwecke). M. H. Yazidjian. Illustrated detailed description. 3500 w. Elektrotech u Maschinenbau—Jan. 17, 1909. No. 2829 D.

Switch Gear for Transformer Installations (Schaltanlagen für Umformerwerke). H. Probst. Illustrates and describes several recent typical installations. Serial. 1st part. 1500 w. Elek Kraft u Bahnen—Jan. 4, 1909. No. 2823 D.

See also Substations, under TRANSMISSION.

We supply copies of these articles. See page 159.

Voltage.

Length and Voltage of Transmission Lines. Alton D. Adams. Discusses the influence of pressure upon electrical transmission. 2500 w. Cassier's Mag—Feb., 1909. No. 2331 B.

Voltage Losses.

Voltage Loss in Alternating-Current Overhead Lines. J. A. Morton. Describes, in terms of British conditions and practice, the method for finding voltage losses as given by C. F. Scott and C. P. Fowler, in the *Elec. Jour.* 1800 w. Elec Rev, Lond—Jan. 8, 1909. No. 1805 A.

Voltage Regulation.

Applications of the Thury Automatic Regulator in Electrical Plants (Applications du Régulateur automatique, Système Thury, dans les Installations électriques). Illustrated detailed description of the apparatus and some of its applications. 2600 w. Génie Civil—Dec. 12, 1908. No. 1929 D.

MISCELLANY.

Electric Piano-Players.

The Development of the Electric Piano Player. John F. Kelly. Reviews work in this field since 1850, especially describing the players now made by the Telelectric Co. Ills. 3500 w. Jour Fr Inst—Jan., 1909. No. 1847 D.

Fire Alarms.

Albany's Fire Alarm Equipment. Illustrated general description of recently completed central office equipment of the fire department. 2000 w. Munic Jour & Engr—Feb. 3, 1909. No. 2235.

Fire Risk.

Electricity and Fire Hazards. Noel Murray. Abridged paper read before the Elec. Assn. of Victoria, Australia. States the principal causes of electrical fires. 3500 w. Aust Min Stand—Dec. 9, 1908. No. 1896 B.

Germany.

Electric Industry in Germany. Waldemar Koch. Reviews important features of its development. 1500 w. Elec Jour—Jan., 1909. No. 2271.

Review of 1908.

The Progress of Electrical Science During 1908. E. E. Fournier d'Albe. A general review. 2500 w. Elect'n, Lond—Feb. 12, 1909. No. 2583 A.

INDUSTRIAL ECONOMY

Accounting.

Machine-Shop Cost Accounting by Machinery. Illustrated description of the tabulating-machine system, explaining its advantages. 2500 w. Am Mach—Vol. 32. No. 7. No. 2512.

Inventory Books for Factories (Inventarienbücher für Industriebetriebe). Herr Lewin. Illustrates and describes two forms. 2500 w. Zeitschr für Werkzeug—Jan. 25, 1909. No. 2694 D.

See also same title, under MINING AND METALLURGY, MINING.

Austria.

Cost of Engineering Materials and Labor in Austria. Editorial, giving authentic figures concerning the cost of labor and engineering materials in different districts. 1700 w. Engng—Feb. 5, 1909. No. 2489 A.

Cost Systems.

Systematic Foundry Operation and Foundry Costs. C. E. Knoeppel. This sixth article of a series deals with foundry organization and management. 3500 w. Engineering Magazine—March, 1909. No. 2786 B.

A Simple Cost System for Complex Situations. John Sturgess. Outlines systems that failed and the reasons, and describes a system enabling accurate costs to be obtained at moderate expense. 3000 w. Engineering Magazine—March, 1909. No. 2784 B.

Depreciation.

Depreciation. A. Winder. Suggestions on methods of determining the loss in value of machinery. 1000 w. Cassier's Mag—Feb., 1909. No. 2332 B.

Education.

The Education and Organization of Railway Enginering Labor. J. E. Muhlfield. A study of the best preparation for success in this field—with general discussion. 12500 w. Pro N Y R R Club—Jan. 15, 1909. No. 2413.

Engineering at the University of Toronto. Walter J. Francis. Illustrates and describes the recent developments, new buildings, improved equipment and facilities for instruction. 3000 w. Engr, Lond—Jan. 29, 1909. Serial. 1st part. No. 2366 A.

The St. Regis Operating Engineers' Training School. Explains the object of the society, and methods. 5000 w. Elec Age—Feb., 1909. No. 2511.

The Education of Foundrymen in France (Ausbildung von Giessereitechnikern in Frankreich). C. Irresberger. Outlines the methods followed in the Ecoles Nationales d'Arts et Métiers. Ills. 2100 w. Stahl u Eisen—Jan. 27, 1909. No. 2666 D.

Franchises.

How New York City Submits Applications for Public Service Franchises to an Engineering Department. With a report of the Franchise Division on an applica-

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tion and an editorial. 7000 w. Eng News —Feb. 11, 1909. No. 2394.

Great Britain.

The Engineering Industries. Extracts from the Tariff Commission Report. 3000 w. Engng—Jan. 29, 1909. Serial. 1st part. No. 2364 A.

Industrial Betterment.

Environment and Its Effects on Workmen and Their Work. Frank Somers. Read before the Birmingham Assn. of Mech. Engrs. Ills. 1800 w. Ir & Coal Trds Rev—Feb. 5, 1909. No. 2497 A.

Industrial Legislation.

Proposed Workmen's Compensation Act in New York. Gives the substance of a bill relating to compensation to workmen for accidental injuries in the course of employment. Also editorial. 2000 w. R R Age Gaz—Feb. 5, 1909. No. 2302.

Kashmir.

Kashmir. Concerning a proposed scheme for the industrial development of this beautiful valley of British India. 3000 w. Engr, Lond—Feb. 12, 1909. No. 2700 A.

Labor.

Arbitration in Railway and Engineering Labor Disputes. Editorial on the settlement, through arbitration, of points of difference between the L. & N.-W. Ry. Co. and its employés, with discussion of the general system of arbitration. 2500 w. Engng—Feb. 12, 1909. No. 2595 A.

Labor Insurance.

Insurance Against Unemployment (L'Assurance contre le Chomage). Maurice Bellom. A comment on M. P. Maurice's articles on this subject in *Le Génie Civil* for Dec. 5, 1908, *et seq.* 3200 w. Génie Civil—Jan. 16, 1909. No. 2642 D.

Management.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. Ninth and last of a series of papers on efficiency ideals and practice, discussing what the system may accomplish. 2000 w. Engineering Magazine—March, 1909. No. 2789 B.

Training Workmen in Habits of Industry and Coöperation. H. L. Gantt's paper is discussed. 9500 w. Jour Am Soc of Mech Engrs—Feb., 1909. No. 2407 F.

See also Wage Systems, under INDUSTRIAL ECONOMY.

Natural Resources.

Forest Potentialities of the South. W. W. Ashe. Information concerning the value of the forest products, and their present condition. 2200 w. Mfrs Rec—Feb. 25, 1909. No. 2744.

Records.

See Record Systems, under CIVIL ENGINEERING, CONSTRUCTION.

Standardization.

Standardization and Its Relation to the Trade of the Country. Sir John Wolfe Barry. A lecture delivered before the Inst. of Engrs. & Shipbldrs. in Scotland. On the work of the Engineering Standards Committee and its benefits. 8000 w. Engng—Jan. 29, 1909. No. 2365 A.

Strikes.

Employers' Insurance Against Strikes. Editorial on the conditions and the object of the Mutual Industrial and Commercial Fund which has been established in the North of France. 3000 w. Engng —Jan. 29, 1909. No. 2362 A.

Tariffs.

The Neutral Line. Henry R. Towne. From a paper read before the Tariff Commission Convention. A plea for scientific regulation of the tariff. 2500 w. Ir Age —Feb. 25, 1909. No. 2745.

Proposed New French Tariff on Iron and Steel. Gives the important changes that have been recommended, with editorial comment. 3000 w. Ir & Coal Trds Rev—Feb. 5, 1909. No. 2496 A.

Wage Systems.

Added Rewards to Workmen. A new plan of the Lodge & Shipley Machine Tool Company explained. 2000 w. Ir Age—Feb. 11, 1909. No. 2388.

The Premium System in a Large Jobbing Shop. T. A. Sperry. Outlines a successful application that effected great reduction in shop costs. 3500 w. Am Mach —Vol. 32. No. 7. No. 2515.

MARINE AND NAVAL ENGINEERING

Battleships.

Comparative Strength of the Navies of the World. An estimate based upon the battleship and cruiser strength. 1700 w. Sci Am—Feb. 20, 1909. No. 2527.

Gas Engines.

Gas Power Aboard Ships. Henry Penton. A critical review of papers by Capt. A. B. Willits. 1800 w. Marine Rev—Feb. 4, 1909. No. 2313.

Adaptability of Producer Gas for Marine Work. E. Shackleton. Read before the Inst. of Marine Engrs. Outlines a scheme for large vessels from 4000 to 5000 tons gross. 2500 w. Int Marine Engng—Feb., 1909. No. 2264 C.

Gasoline Engines.

A New Reversing Motor for Launches and Yachts. G. O. M. Olsson. Explains the operation of a reversing internal com-

bustion motor. Ills. 2000 w. Int Marine Engng—Feb., 1909. No. 2263 C.

Ice Breakers.

Ocean and River Ice (Les Glaces de Mer, Glaces de Rivières, Manœuvres de Préservation et de Deglaçage). M. Dibos. A discussion of glaciology in its relation to the problems of ocean and river navigation. Ills. 23000 w. Mem Soc Ing Civ de France—Nov., 1908. No. 2604 G.

Life-Saving Appliances.

Novel Life-Saving Apparatus. A cylindrical cage built of rope ladders anchored by iron hoops, is illustrated and described. It is simple in design and operation and has been adopted by the German Admirality. 700 w. Sci Am—Feb. 13, 1909. No. 2400.

Model Basins.

The Development and Present Status of the Experimental Model-Towing Basin. H. A. Everett. Illustrates and describes a number of these tanks. 2500 w. Int Marine Engng—Feb., 1909. Serial. 1st part. No. 2261 C.

Oil Engines.

The Application of the Diesel Motor to Marine Work (Application du Moteur Diesel à la Navigation). A. Bochet. A description of types and of results in service with a review of possible developments. Ills. 5200 w. Mem Soc Ing Civ de France—Nov., 1908. No. 2603 G.

Propellers.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Salvage Steamers.

An American Salvage and Repair Steamer. Illustrated description of the steamer "Favorite," in use on the Great Lakes. It is of steel construction and built for heavy weather. 1000 w. Engr, Lond—Feb. 5, 1909. No. 2492 A.

Ship Design.

Unsinkable and Uncapsizable Ships. Gen. E. E. Goulaeff. Read before the Inst. of Naval Archts. Illustrates and describes the Goulaeff form and system of construction. 5500 w. Sci Am Sup—Feb. 13, 1909. No. 2403.

The New Freeboard Regulations of the German Marine Association and Modern Steamships (Die neuen Freibordvorschriften der See-Berufsgenossenschaft und die modernen Dampfertypen). Carl Kielhorn. Discusses the effect of the regulations on the cost and powering of ships. Ills. 6000 w. Schiffbau—Jan. 13, 1909. No. 2685 D.

Ship Heating.

The Heating of Modern Ocean Liners. W. Carlile Wallace. From a paper read before the Inst. of Naval Archts. Detailed discussion of systems used on a number of vessels, cost, etc. 3500 w. Int Marine Engng—Feb., 1909. No. 2259 C.

Piping Up a Merchant Vessel for Steam Heat. Allan Dale. Information based on experience. 3000 w. Int Marine Engng—Feb., 1909. No. 2260 C.

Ship Stabilty.

Apparatus for Recording the Rolling and Pitching of Ships. Illustration and translated description from *Zeit. für Instrumentenkunde.* 900 w. Engng—Feb. 12, 1909. No. 2590 A.

The Stability of Steamships (Stabilité des Bateaux à Vapeur). M. Cornaz. A general discussion. 4500 w. Bul Tech d l Suisse Romande—Jan. 25, 1909. No. 2628 D.

Ship Ventilation.

Ventilating Plants on Shipboard (Note au Sujet des Installations de Ventilation à Bord des Navires). M. Boris. An exhaustive discussion of their design and installation. Ills. Serial. 1st part. 8500 w. Rev de Mécan—Jan., 1909. No. 2623 E + F.

Steam Engines.

The Efficiency of Marine Engines and Propellers. J. Hamilton Gibson. Suggestions bearing on the problem of mechanical efficiency of marine engines. 2000 w. Engr, Lond—Jan. 29, 1909. No. 2368 A.

See also Locomotives, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steamships.

Steam Collier or Ore Vessels Adapted for Belt Conveyor Discharge. Gives illustrated description of a new type of vessel in which the coal or ore is discharged by belt-conveyors. 1400 w. Ir & Coal Trds Rev—Jan. 29, 1909. No. 2373 A.

The Pacific Steam Navigation Company's Twin-Screw Steamer "Orcoma." Illustrations, deck plans and description of a vessel built for high economy in the merchant service. 900 w. Engng—Feb. 12, 1909. Serial. 1st part. No. 2592 A.

The Twin-Screw Passenger and Freight Steamship "Prinz Friedrich Wilhelm" (Der Doppelschrauben-Personen- und Frachtdampfer "Prinz Friedrich Wilhelm"). Illustrated description of this new North German Lloyd liner. Serial. 1st part. 2300 w. Zeitschr d Ver Deutscher Ing—Jan. 2, 1909. No. 2834 D.

The Twin-Screw Passenger and Freight Steamship "George Washington" of the North German Lloyd (Der Doppelschrauben-Passagier- und Frachtdampfer "George Washington" des Norddeutschen Lloyd). Paul Driessen. Illustrated detailed description. Plates. 20000 w. Schiffbau—Jan. 27, 1909. No. 2686 D.

Tugs.

A Large Sea-Going Tug. Illustrated description of the "Mary F. Scully," built

at Staten Island. 1200 w. Int Marine Engng—Feb., 1909. No. 2262 C.

U. S. Merchant Marine.

The Rehabilitation of the American Merchant Marine. Samuel Holmes. Reviews briefly the history of the American mercantile marine, explaining the present situation. 3500 w. Naut Gaz—Jan. 28, 1909. Serial. 1st part. No. 2166.

U. S. Navy.

The Engineering Question in the United States Navy. Critical discussion of the abolition of the bureau system and the control of engineering work by the naval constructor. 4000 w. Engineering Magazine—March, 1909. No. 2783 B.

Yachts.

The New American Magnetic Survey Yacht Carnegie. Explains the need of frequent examination of the state of magnetism of the earth, and gives illustrated description of a vessel specially designed for the work. 2200 w. Naut Gaz—Jan. 28, 1909. No. 2165.

MECHANICAL ENGINEERING

AUTOMOBILES.

Belsize.

The 14-16 h.p. Belsize. Illustrated description of a medium powered car. 1500 w. Autocar—Jan. 30, 1909. No. 2338 A.

Berliet.

The 15-H.P. Live-Axle Berliet. Illustrated detailed description. 1600 w. Auto Jour—Feb. 13, 1909. No. 2578 A.

Brakes.

Modern Trend of Design in Motor Brakes. Lawrence Whitcomb and Thomas J. Fay. Read before the Soc. of Auto. Engrs. Discusses the design of brakes in connection with the clutch. 4500 w. Automobile—Feb. 18, 1909. No. 2533.

Carburettors.

The Zenith Carburettor. Illustrated description of an automatic carburettor for which the designers claim that absolute self-regulation is obtained without the introduction of auxiliary air or the use of any moving parts. 1800 w. Auto Jour—Jan. 30, 1909. No. 2342 A.

Commercial Vehicles.

A Heavy Oil Motor Wagon. Illustrated description of a vehicle for use in South America. 1200 w. Engr, Lond—Jan. 22, 1909. No. 2225 A.

Electric.

Modern Electric Automobiles (Moderne Elektromobile). K. Schirmbeck. Illustrates and describes recent types. 3600 w. Zeitschr d Mit Motorwagen-Ver—Jan. 15, 1909. No. 2800 D.

Electric Dynamos.

The Dynamo. Illustrates and describes a new system of making electricity on the car. 1200 w. Auto Jour—Jan. 30, 1909. No. 2341 A.

Exhibitions.

Automobile Progress in 1908 (Les Progrès de l'Automobilisme en 1908). F. Drouin. Illustrated review of progress and improvements as shown at the Paris "Salon." Serial. 1st part. 3200 w. Génie Civil—Jan. 16, 1909. No. 2641 D.

Aeronautics and Commercial Vehicles at the Paris "Salon" (Le Salon de l'Aéronautique et des Véhicules industriels). G. Espitallier. Describes some of the exhibits. Ills. 5500 w. Génie Civil—Jan. 9, 1909. No. 2639 D.

Farm Motors.

An Egyptian Cultivator. A machine of original construction is described. Ills. 1200 w. Sci Am—Feb. 13, 1909. No. 2399.

Germain.

The 20 h.p. Germain. Illustrated description of new type of light 6-cylinder car. 1400 w. Autocar—Feb. 13, 1909. No. 2577 A.

Ignition.

Ten Years' Progress in Magneto Ignition. J. A. Williams. Discusses the subject of electric ignition. 2500 w. Automobile—Feb. 25, 1909. No. 2771.

Itala.

The 16-20 h.p. Itala. Brief illustrated description. 600 w. Autocar—Feb. 6, 1909. No. 2475 A.

Light Cars.

Light Cars. (Das Kleinauto). Herr Schwerdtfeger. Discusses their development and suggests means of simpifying their construction. Ills. 2800 w. Zeitschr d Mit Motorwagen Ver—Jan. 30, 1909. No. 2801 D.

Motors.

New and Novel Designs in French Motors. W. F. Bradley. Illustrated descriptions of the Aries 4-cylinder motor, and of the Korwin & Rebikoff 3-cycle motor. 1200 w. Automobile—Feb. 18, 1909. No. 2532.

See also Piston Rings, under MACHINE ELEMENTS AND DESIGN.

Sleighs.

Motoring on Runners. Illustrates and describes experimental motor sleds. 1500 w. Sci Am—Feb. 27, 1909. No. 2780.

Speedwell.

1909 Speedwell. Illustrated detailed description, calling attention to recent

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improvements. 1500 w. Automobile—Feb. 11, 1909. No. 2439.

Tires.

True Story of the Automobile Tire. H. S. Firestone. A brief account of methods of gathering rubber and preparing it for use, the combination with cotton in making tires, etc. Ills. 1400 w. Automobile—Feb. 11, 1909. No. 2438.

Automobile Pneumatics at the Paris Road Congress (Der Automobilpneumatik auf dem Pariser Strassenkongress). Herr Krastel. Reviews the discussions on the effect of high-speed automobiles on roads, etc. Ills. 2600 w. Motorwagen—Jan. 10, 1909. No. 2803 D.

Transmissions.

A Hydraulic Variable Speed Transmission. Illustrated detailed description of the Manly Drive, with report of tests. 1700 w. Eng News—Feb. 18, 1909. No. 2523.

COMBUSTION MOTORS.

Fuels.

Denatured Alcohol and Its Industrial Applications (L'Alcool dénaturée et ses Emplois industriels). Albert Dulac. A review of its production and use as a motor fuel in France. Ills. Serial. 1st part. 2000 w. Tech Mod—Dec., 1908. No. 2633 D.

Gas Calorimetry.

See Calorimetry, under MEASUREMENT.

Gas Engine Design.

To Determine Size of Gas and Oil Engine Cylinders. Newton Wright. Gives formulae with explanatory notes. 900 w. Mach, N Y—Feb., 1909. No. 2244 C.

Gas Engine Efficiency.

A Graphical Method of Calculating Gas-Engine Efficiencies. Edward William Hollingworth. An explanation of a method for calculating the theoretical efficiency of gas-engines. 1500 w. Inst of Civ Engrs—No. 3750. No. 2791 N.

Gas Engines.

The Theory of Explosion and Combustion Motors (Introduction à l'Etablissement de la Théorie des Moteurs à l'Explosion et à Combustion). L. Letombe. A general discussion. Ills. 4500 w. Tech Mod—Jan., 1909. No. 2634 D.

Increasing the Efficiency and Capacity of Large Gas Engines by Cooling the Charge. F. E. Junge. Comments on the results of Prof. Junker's investigations to ascertain the influence of charge temperature. 1000 w. Power—Feb. 2, 1909. No. 2189.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Blowing Engines, under MINING AND METALLURGY, IRON AND STEEL.

Gas Metering.

Experiments on a Method of Measuring the Air- or Gas-Supply to Engines and Furnaces. Andrew George Ashcroft. Describes experiments made in connection with a series of tests on internal combustion engines. Ills. 1700 w. Inst of Civ Engrs—No. 3778. No. 2798 N.

Gasoline Engines.

Proportions of Diameter and Stroke in Petrol Engines. A discussion of what proportions give the lightest engine and the most convenient arrangement of parts. Ills. 2500 w. Engng—Jan. 22, 1909. No. 2218 A.

Foreign Aeronautic Motors. Some of the latest light-weight gasoline engines for flying machines that have been brought out in Europe are illustrated and described. 3000 w. Sci Am Sup—Feb. 13, 1909. Serial. 1st part. No. 2405.

Gasoline Turbines.

Test of a Gasoline Turbine (Essai d'une Turbine à Pétrole). Alfred Barbezat. Describes the machine, its theory, the tests and the significance of their results. Ills. 2200 w. Schweiz Bau—Jan. 16, 1909. No. 2690 B.

Gas Power Plants.

Suction Gas Producer Power. L. P Tolman. Deals with suction gas power plants in single units of 200 h.p. and smaller, and complete plants made up of a number of such units 1000 h.p or larger. Ills. 4500 w. Cal Jour of Tech—Jan., 1909. No. 2712.

Letombe Power Gas Installation of 1000 Indicated Horse-Power Capacity. Illustrated description translated from *Revue Ind.* 3000 w. Mech Engr—Feb. 5, 1909. No. 2478 A.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gas Producers.

A Process of Making Gas from Oil. Walter C. Willard. Illustrates and describes a method and apparatus which utilizes residuum oil, reporting tests. 2500 w. Ir Trd Rev—Feb. 11, 1909. No. 2441.

Pyrometers in Gas Producer Operations. R. L. Frink. An account of results obtained by a method of controlling the fires by means of temperature indication, and by the use of a properly installed pyrometer. 2500 w. Pro Age—Feb. 15, 1909. No. 2455.

Gas Producers and Gas Firing. Ernest Schmatolla. Presents the advantages of gas producers in their fuel economy, smoke prevention, etc., illustrating and describing types and explaining their operation. 6000 w. Min Jour—Feb. 6, 1909. No. 2481 A.

Oil Engines.

See Gas Engine Design, under COMBUSTION MOTORS, and Oil Engines, under MARINE AND NAVAL ENGINEERING.

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HEATING AND COOLING.

Air Filtration.

The Combemale System of Air Filtration (Le Filtrage de l'Air, Système Combemale). J. J. Pillet. Illustrated description. 1800 w. Bul Soc d'Encour—Dec., 1908. No. 2621 G.

Central Plants.

The Operation of Central Heating Plants in Office Buildings (Mitteilungen über den Betrieb von Zentralheizungen in Amtsgebäuden). Leopold Nowotny. A practical discussion of possible difficulties. Ills. 2900 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 2, 1909. No. 2815 D.

Cooling Towers.

Cooling Towers. H. F. Blake. Classifies and describes types, with remarks on their use and efficiency. 2000 w. Power —Feb. 9, 1909. No. 2380.

Electric Heating.

See Heating, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

Piping.

Cast Iron Pipe and Fittings—Their Defects. Charles R. Schmidt. Discusses the subject of house drainage, soil pipes, and fittings, etc. Ills. 3500 w. Dom Engng—Feb. 20, 1909. No. 2572.

Refrigeration.

Refrigerating Machines, Compression, Absorption. Gardner T. Voorhees. Comparison of capacities and economies of compression and absorption systems and of the combined system. 3000 w. Ice & Refrig—Feb., 1909. No. 2289 C.

See also Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Ventilation.

A Central Controller for a Ventilating Plant with Automatic Regulation of the Air Temperature (Zentralschalter für Lüftungsanlagen mit selbsttätiger Regulierung der Zulufttemperatur). Herr Arnoldt. A detailed description of an installation of this type. Ills. 2800 w. Gesundheits-Ing—Jan. 9, 1909. No. 2806 D.

See also Wind, under HEATING AND COOLING.

Wind.

Effect of Wind on Heating and Ventilating. H. W. Whitten. Read before the Am. Soc. of Heat. & Vent. Engrs. Discusses air leakage and reports tests made. 1500 w. Met Work—Jan. 30, 1909. No. 2170.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Centrifugal Pumps. E. N. Percy. Reviews some of the advantages and applications of centrifugal pumps. 1700 w. Mach, N Y—Feb., 1909. No. 2243 C.

The Theory of Centrifugal Pumps and Fans under Variable Operating Conditions on the Hypothesis of a Parabolic Q-H Characteristic (Zur Theorie der Zentrifugalpumpen und Ventilatoren bei veränderlichen. Betriebsbedingungen unter Voraussetzung einer parabolischen Q-H-Charakteristik). E. Busse. Mathematical. Ills. Serial. 1st part. 1800 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 9, 1909. No. 2696 D.

Cornish Pumps.

Cornish Pumps and Pumping Engines. Henry F. Collins. Notes on the advantages of Cornish pumping. 1800 w. Min & Sci Pr—Feb. 20, 1909. Serial. 1st part. No. 2765.

Electric Pumping.

The Electro-Hydraulic Pumping Plant at the Bristol Docks. W. A. Clatworthy. Read before the Newcastle Sec. of Inst. of Elec. Engrs. Illustrated description of a plant to provide power for operating cranes, capstans, lock gates, bridges, etc., in connection with the Bristol Docks. 2500 w. Elec Engr, Lond—Feb. 12, 1909. No. 2581 A.

Hydrodynamics.

The Influence of Molecular Attraction on Hydrodynamic Theory (Sull' Influenza delle Attrazioni molecolari nei Fatti idrodinamici). P. Alibrandi. A mathematical and theoretical discussion of fundamental hydraulic theorems. Ills. 5200 w. Ann d Soc d'Ing e d Arch Ital—Jan. 1, 1909. No. 2648 F.

Penstocks.

Penstocks for Water Power Plants. Frank Koester. Information concerning recent practice, materials used, methods of construction, etc. Ills. 3000 w. Eng Rec —Feb. 20, 1909. No. 2565.

Pumping Engines.

See also Cornish Pumps, under HYDRAULIC MACHINERY.

Pumping Plants.

Pumping Station for Flood-Water at Southsea. Illustrates and describes the object and construction of this important engineering work and the appliances by which the mechanical work is automatically carried on. 3000 w. Engng—Jan. 22, 1909. No. 2219 A.

See also Electric Pumping, under HYDRAULIC MACHINERY.

Pumps.

Miscellaneous Improvements. W. H. Wakeman. Illustrates and describes some pump governors, lubricators, etc. 1500 w. Power—Feb. 9, 1909. No. 2375.

Pump with Increased Efficiency at High Speeds. Illustrated description of a recent invention by Hans Milner, Austria, and the method of operation. 1500 w. Prac Engr—Jan. 22, 1909. No. 2210 A.

Gas Engine-Driven Accumulator Pumps. Illustrations with brief descriptions. 500

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w. Engr, Lond—Jan. 22, 1907. No. 2224 A.

See also Machinery, and Pumping, under MINING AND METALLURGY, MINING.

Surge Tanks.

A Note on the Design of Surge Tanks (Beitrag zur Bemessung des Inhalts von Wasserschlossern). Discusses mathematically the method of determining the capacity for which they should be designed. Ills. 1700 w. Schweiz Bau—Jan. 30, 1909. No. 2692 B.

Turbine Plants.

See Penstocks and Surge Tanks, under HYDRAULIC MACHINERY.

MACHINE ELEMENTS AND DESIGN.

Cams.

A Few Notes on Cam Design. Bertram C. Joy. Studies the problem of designing a cam which will give the best combination of silent running with powerful working. 2500 w. Autocar—Jan. 30, 1909. No. 2339 A.

Chucks.

The Evolution of the Magnetic Chuck. O. S. Walker. Aims to correct wrong impressions in regard to the operation of magnetic chucks, and to illustrate some special applications. Ills. 1800 w. Am Mach—Vol 32. No. 6. No. 2459.

Clutches.

Theory and Design of Friction Clutches. Michael Richard Conway. Discusses the limitations of materials and workmanship, features of design, etc. Ills. 2500 w. Am Mach—Vol. 32. No. 7. No. 2513.

Gears.

Skew Bevel Gears. J. A. Utts. Illustrates details of the gears and describes method of making them. 1000 w. Am Mach—Vol. 32. No. 8. No. 2775.

Interchangeable Involute Gear Tooth Systems. Discussion of Ralph E. Flanders' paper. 8500 w. Jour Am Soc of Mech Engrs—Feb., 1909. No. 2410 F.

Spur Gearing on Heavy Railway Motor Equipments. A discussion of Norman Litchfield's paper dealing with the breakage of gearing in heavy electric railway service. 3500 w. Jour Am Soc of Mech Engrs—Feb., 1909. No. 2409 F.

Piston Rings.

Design and Manufacture of Piston Rings. Rene M. Petard. Describes current French automobile practice for making theoretically correct rings. Ills. 3500 w. Am Mach—Vol. 32 No. 5. No. 2258.

Screw Threads.

Interchangeability and Methods of Securing it in Screw-Threads. H. F. Donaldson. Lecture delivered at the graduates meeting of the Inst. of Mech. Engrs. Considers the difficulties and means of overcoming them. 4000 w. Engng—Feb. 12, 1909. Serial. 1st part. No. 2593 A.

The Elimination of the V-Thread. Discusses the adoption of the United States standard by tap and die makers. 1800 w. Ir Age—Feb. 25, 1909. No. 2746.

Speed Variation.

See Transmissions, under AUTOMOBILES.

Strength of Materials.

Working Stress. F. W. Wright. Gives information based on Wohler's experiments, also results of other experiments, and formulae used. 1500 w. Mech Wld—Feb. 12, 1909. Serial. 1st part. No. 2588 A.

Problems in the Strength of Materials Solved by Elementary Mathematics in the Night-Courses of the Institute. Lucien E. Picolet. Discusses representative problems. 2000 w. Jour Fr Inst—Feb., 1909. No. 2741 D.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

Lay Out of a Horizontal Return Tubular Boiler 18 Feet Long by 72 Inches Diameter. R. R. Sturgeon. Gives specifications and shows by sketches how a boiler of this type would be laid out in the shop. 2000 w. Boiler Maker—Feb., 1909. No. 2319.

See also Welding, under MACHINE WORKS AND FOUNDRIES.

Boring.

Special Boring Fixtures for Bench Lathe Heads. Describes and illustrates work on an accurately constructed bench machine. 1000 w. Am Mach—Vol. 32. No. 6. No. 2460.

Boring Machines.

8-Inch-Spindle Horizontal Boring, Milling, Drilling, Tapping, and Studding Machine. Illustrated description of the machine and its operation. 700 w. Engng—Jan. 29, 1909. No. 2360 A.

Brass Founding.

The Art of Casting Manganese-Bronze, and the Manner in Which the Difficulties Are Overcome. Illustrated article with directions for securing the best results. 2500 w. Brass Wld—Feb., 1909. No. 2721.

Case Hardening.

Case Hardening (Ueber Zementieren). B. Neumann. A review of recent researches and progress. Ills. Serial. 1st part. 1300 w. Giesserei-Zeit—Jan. 1, 1909. No. 2680 D.

Castings.

The Manufacture of Steel Castings in Small Quantities. Arthur Simonson. Read before the Phila. Found. Assn. Describes the manufacture with a converter of 1000-lbs. capacity, by the new Tropenas system. Ills. 4500 w. Foundry—Feb., 1909. No. 2254.

Steel Foundry Shrinkage Problems. R.

A. Bull. Discusses the causes of shrinkage in steel castings and methods of overcoming this difficulty. 3500 w. Ir Trd Rev—Feb. 25, 1909. No. 2770.

Sponginess on the Upper Surface of Castings. D. Wilkinson, Jr. Discusses the causes and the suggestions that have been offered for overcoming the difficulty, but states the problem is not solved. 3000 w. Mech Wld—Jan. 29, 1909. No. 2354 A.

See also Brass Founding, under MACHINE WORKS AND FOUNDRIES; and Steel Making, under MINING AND METALLURGY, IRON AND STEEL.

Chain Making.

Chains of Seamless Rolled or Pressed Links (Ueber nahtlose Walz- und Pressketten). Otto Klatte. Discusses their manufacture, strength, etc. Ills. 2500 w. Stahl u Eisen—Jan. 20, 1909. No. 2664 D.

Cupola Charging.

Old and New Methods of Cupola Charging (Alte und neue Kupolofenbeschickung). Th. Ehrhardt. Illustrates and describes a number of methods and devices. 3000 w. Stahl u Eisen—Jan. 13, 1909. No. 2659 D.

Cupola Design.

The Determination of the Dimensions of Cupolas and the Osann Theory (Berechnung von Kupolofenabmessungen und die Theorie Osann). Carl Rein. An explanation of the Osann theory. Ills. Serial. 1st part. 2000 w. Giesserei-Zeit—Jan. 1, 1909. No. 2681 D.

Cupola Practice.

Cupola Operation with Dry and Wet Coke (Betrachtungen über das Kupolofenschmelzen mit trockenem und nassem Koks.) C. Geiger. A report of observations extending over several weeks. Ills. 6000 w. Stahl u Eisen—Jan. 13, 1909. No. 2661 D.

Enamelling.

Annealing and Pickling in the Enamelling Industry (Ueber das Glühen und Beizen der fertigen Eisenrohware in der Emailindustrie). Julius Grünwald. A review of modern practice. 2000 w. Stahl u Eisen—Jan. 27, 1909. No. 2667 D.

Forging.

The Making of Large Drop Forgings. E. F. Lake. Illustrates and describes different operations in forging a 400 pound crank shaft. 900 w. Am Mach—Vol. 32. No. 5. No. 2256.

Foundry Furnaces.

The Small Open Hearth Furnace for Steel Castings. W. M. Carr. Illustrates and describes a small stationary open-hearth furnace using liquid fuel, presenting its advantages. 1500 w. Ir Age—Feb. 11, 1909. No. 2386.

Foundry Materials.

Plumbago in the Foundry. Walter J. May. Its value as a sleeking material, for crucibles, and other uses. 600 w. Prac Engr—Jan. 29, 1909. No. 2349 A.

Foundry Practice.

A Machine Foundry for Special Work. Illustrates and describes methods pursued in the new plant of the General Electric Co., where molding machines are used exclusively. 2500 w. Foundry—Feb., 1909. No. 2252.

Furnaces.

Electric Annealing Furnaces for Hardening and Tempering High-Class Tools. John B. C. Kershaw. Explains the advantages of electric heating for this work, and illustrates and describes types of furnaces. 1800 w. Elec Wld—Feb. 18, 1909. No. 2518.

Gear Cutting.

Recent Developments in Gear-Cutting Machinery. Ralph E. Flanders. Illustrates and describes new machines. 2500 w. Mach, N Y—Feb., 1909. No. 2242 C.

See also Gears, under MACHINE ELEMENTS AND DESIGN.

Molding Machines.

Molding Machines for Large Work. An illustrated description of practice at a plant where molds weighing 10000 pounds and over are rammed on jarring machines. 1000 w. Foundry—Feb., 1909. No. 2248.

See also Foundry Practice, under MACHINE WORKS AND FOUNDRIES.

Pattern Shops.

Distribution of Pattern Shop Work. Oscar E. Perrigo. Discusses the routine of this department with a modern system. 4500 w. Foundry—Feb., 1909. No. 2250.

Press Tools.

Press Tools Used in Clock Manufacture. Charles Doescher. Drawings and descriptions of sub press and other punches and dies. 3000 w. Am Mach—Vol. 32. No. 5. No. 2255.

Sectional Blanking and Shaving Dies. Describes and illustrates press tools of unusual construction. 2000 w. Am Mach—Vol. 32. No. 8. No. 2773.

Rivetting Machines.

New Piat Electro-Hydraulic Riveters (Nouvelles Riveuses électro-hydrauliques Système Piat). Illustrated detailed description. 4000 w. Génie Civil—Jan. 30, 1909. No. 2645 D.

Safety Devices.

See same title, under MISCELLANY.

Shop Accidents.

An Analysis of 5500 Machine-Shop Accidents. L. P. Alford. An analysis based on shop-hospital records, showing that most accidents were due to the natural hazards of the occupation. 4000 w. Am Mach—Vol. 32. No. 6. No. 2457.

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Shop Appliances.

Fixtures Used in Machining Miller Parts. A. J. Baker. Describes tools which handle two parts cast in one piece and cut apart afterwards. Ills. 1500 w. Am Mach—Vol. 32. No. 8. No. 2774.

Application of Lifting Devices to Assembling Work. Alfred Spangenberg. Illustrates and describes simple devices for handling work. 1300 w. Mach, N Y—Feb., 1909. No. 2246 C.

Shop Heating.

Shop Heating—A Treatise Containing Many Practical Suggestions. F. R. Still. Explains how a system should be laid out and operated to assure the best results. 3500 w. Foundry—Feb., 1909. No. 2249.

Shop Hygiene.

See Textile Mills, under MISCELLANY.

Shop Practice.

Axle Turning—Methods and Production. A study of the conditions that tend toward large output. 3500 w. Mach, N Y—Feb., 1909. No. 2241 C.

Machining a Cast-Iron Lathe Headstock. G. H. Gibbs. Prize paper. Illustrates and describes the different operations, giving time required for each. 2500 w. Mech Wld—Jan. 22, 1909. No. 2213 A.

Shops.

The Curtis Electric Car Truck Plant. Illustrated detailed description of new works at Decatur, Ill. The buildings are fireproof, and the arrangements for handling material are shown. 2500 w. Ir Age—Feb. 18, 1909. No. 2507.

Shop Ventilation.

Ventilation of Factory Buildings in New York State. Information obtained by the State Department of Labor, showing a serious condition. 3500 w. Heat & Vent Mag—Feb., 1909. No. 2742.

Tempering.

Where, in Relation to the Critical Points, Should Steel Be Heated for the Best Results When Hardening? W. Osborne. Discusses what quenching point will give the best results. 1800 w. Am Mach—Vol. 32. No. 6. No. 2458.

See also Furnaces, under MACHINE WORKS AND FOUNDRIES; and Tool Steels, under MATERIALS OF CONSTRUCTION.

Tempering Colors.

A Note on Tempering Colors (Note sur les Couleurs de Revenu). Léon Guillet and Albert Portevin. Cites experiments which show that the colors are a reliable guide in the heat treatment of steel. 1500 w. Rev de Métal—Jan., 1909. No. 2619 E + F.

Tinning.

Old and New Methods of Tinning Metals (Das Verzinnen von Metallgegenständen in alter und neuer Zeit). Otto Vogel. A historical review. 5000 w Stahl u Eisen—Jan. 13, 1909. No. 2660 D.

Tool Making.

Lathe Kinks. Paul W. Abbott. Gives schemes devised for doing tool work where there was no milling machine or drill press. Ills. 2000 w. Mach, N Y—Feb., 1909. No. 2245 C.

Welding.

Electric Welding in the Boiler Shop. E. A. Dixie. Concerning the comparative costs and strengths of riveted, gas welded and electric welded seams. Ills. 3500 w. Am Mach—Vol. 32. No. 8. No. 2772.

The Repair of Marine Boilers by Autogenous Welding (Schiffskesselreparaturen mittels Acetylen-Sauerstoff-Schweissung). Herr Hilpert. Illustrates and describes appliances and methods. Serial. 1st part. 3300 w. Glasers Ann—Jan. 1, 1909. No. 2699 D.

Woodworking Machinery.

Some Reasons Why Good Saws Fail. J. Mason. Considers some of the causes of failures of this tool. 1800 w. Wood Craft—Feb., 1909. No. 2285.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Nature and Characteristics of the New Steels. O. M. Becker. Second and concluding paper, dealing with the influence of each of the ordinary alloy elements on the properties of steel. 5000 w. Engineering Magazine—March, 1909. No. 2787 B.

Effect of Titanium Alloy on Steel. Charles V. Slocum. Gives results obtained at various steel plants. Ills. 2500 w. Ir Trd Rev—Feb. 25, 1909. No. 2769.

See also Electro-Metallurgy, under MINING AND METALLURGY, IRON AND STEEL.

Aluminium.

See same title, under MINING AND METALLURGY, MINOR MINERALS.

Bearing Metals.

Bearing Metals. A. Hague. Abstract of paper read before the Staffordshire Ir. & St. Inst. Divides the bearing metals into rigid bronzes, plastic white metals, and the plastic bronzes, considering each separately. 3500 w. Ir & Coal Trds Rev—Feb. 5, 1909. No. 2495 A.

Bronzes.

Composition of the Modern Bronzes. C. Vickers. Read before the Pittsburg Found. Assn. Discusses the dioxidizing elements used in copper alloys for increasing their tensile strength and ductility. 2500 w. Foundry—Feb., 1909. No. 2253.

Cast Iron.

The Use of Vanadium in Cast Iron. J. Kent Smith. Explains the action of this metal on grey iron for casting purposes and methods of application in the ladle

and air furnaces. 3000 w. Foundry—Feb., 1909. No. 2251.

The Influence of Foreign Elements on the Strength of Cast Iron (Der Einfluss der Fremdkörper auf die Festigkeitseigenschaften des Gusseisens). Max Orthey. Discusses the effect of the various impurities commonly found. Serial. 1st part. 1500 w. Giesserei-Zeit—Jan. 1, 1909. No. 2683 D.

Copper.

Fatigue of Copper Pipes. James M. Allan. Abstract of paper read before the N.-E. Coast Inst. of Engrs. and Shipbldrs. Describes tests made, reporting results. Ills. 4000 w. Mech Engr—Feb. 5, 1909. No. 2479 A.

Elastic Breakdown.

The Elastic Breakdown of Materials. Submitted to Compound Stresses. L. B. Turner. The present number gives an introductory, critical review of investigations in this field, and will be followed by results of experiments by the author. 3300 w. Engng—Feb. 5, 1909. Serial. 1st part. No. 2485 A.

Hardness.

The Influence of Heat on the Hardness of Metals (Untersuchungen über den Einfluss der Wärme auf die Härte der Metalle). Alfred Kürth. Describes and gives the results of recent extensive researches. Ills. Serial, 1st part. 6600 w. Zeitschr d Ver Deutscher Ing—Jan. 16, 1909. No. 2836 D.

Metallography.

The Mysteries of Metals. Abstract of a lecture by Prof. J. O. Arnold, the first of a course at the Royal Inst. Ills. 2500 w. Engng—Jan. 29, 1909. Serial, 1st part. No. 2359 A.

Lecture on "Composition and Constitution." Edward F. Law. On the importance of amplifying ordinary analysis by a structural and constitutional analysis. 2 plates. 3500 w. Jour W of Scotland Ir & St Inst—Nov. and Dec., 1908. No. 2430 N.

Lieutenant-Colonel Caron (Le Lieutenant-Colonel Caron). Paul Nicolardot. A sketch of his life and of his contributions to the science of metallurgy. Ills. 28000 w. Rev de Métal—Jan., 1909. No. 2615 E + F.

Steel.

Sparks as an Indication of the Qualities of Steel (Die Funken als Erkennungszeichen der Stahlsorten). Max. Bermann. A discussion of what may be deduced concerning the qualities and composition of steels from the sparks made in grinding. Ills. 6500 w. Zeitschr d Ver Deutcher Ing—Jan. 30, 1909. No. 2841 D.

See also Boiler Design, under STEAM ENGINEERING.

Tool Steels.

Remarkable Facts in Tempering Tool Steels. Albert F. Shore. A valuable article giving data disclosed by the scleroscope and compound-stress machine. Ills. 5500 w. Am Mach—Vol. 32, No. 6. No. 2461.

The Manufacture of High-Speed Steel. O. M. Becker. Discusses the practical application of the high-heat treatment to hardening. Ills. 7000 w. Cassier's Mag—Feb., 1909. No. 2328 B.

MEASUREMENT.

Calorimetry.

Report of Sub-Committee on Calorimetry. Report presented at the Oct. meeting of the Am. Gas Inst., with illustrated descriptions of types of calorimeters, and short discussion. 17000 w. Pro Age—Feb. 15, 1909. No. 2456.

Hardness.

A Simplified Ball Hardness Test and Some of Its Results (Dispositif pour un Essai simplifié de Dureté à la Bille et Résultats obtenus). A. Martens and C. Heyn. Translated from the *Zeitschrift des Vereines Deutscher Ingenieure* for Oct. 24, 1908. Ills. 4000 w. Rev de Métal—Jan., 1909. No. 2620 E + F.

Impact Test.

Investigation of the Shock Test at Variable Temperatures (Expériences sur l'Essai au Choc à Température variable). Léon Guillet and L. Révillon. Gives results of tests to show the variations in results of impact tests at different temperatures. Ills. 3000 w. Rév de Métal—Jan., 1909. No. 2618 E + F.

Laboratories.

The Testing Establishment of the Technical College of Berlin. An account of work for the year 1907 is reviewed. 1200 w. Engr, Lond—Jan. 22, 1909. No. 2223 A.

Metric System.

See Units, under ELECTRICAL ENGINEERING, MEASUREMENT.

Pyrometry.

See Gas Producers, under COMBUSTION MOTORS.

Thermometry.

A Sensitive Thermometer. Prof. S. A. Mitchell. Refers briefly to various thermometers used in research work, and describes in detail the volometric apparatus which has been brought to a high degree of refinement by Prof. C. G. Abbot. Ills. 2000 w. Sci Am—Feb. 6, 1909. No. 2282.

Scale and Table, Giving Equivalent Graduations of the Fahrenheit and Centigrade Thermometers. Gives the equivalents without calculation, illustrating the use by examples. 800 w. Power—Feb. 2, 1909. No. 2193.

We supply copies of these articles. See page 159.

POWER AND TRANSMISSION.

Air Compressors.

See Machinery, under MINING AND METALLURGY, MINING.

Electric Driving.

Industrial Engineering. H. W. Peck. Describes methods of solving the present day problems of power, giving method of determining the motor equipment required, etc. Ills. 3000 w. Elec Jour—Feb., 1909. No. 2737.

Electricity in an Indian Railway Workshop. Illustrated description of an installation at Lahore (Punjab). 3000 w. Elec Rev, Lond—Jan. 29, 1909. No. 2345 A.

Electric Motors in a Brewery. William Keily. Illustrates and describes applications of electric power in the plant of the Pabst Brewing Co., Milwaukee, Wis. 1500 w. Elec Wld—Feb. 4, 1909. No. 2268.

See also Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Electric Power.

Electricity and Its Application to the Reduction of Waste. A. B. Gridley. Deals with the various ways in which electricity saves "waste." Also the question of price. 3500 w. Elect'n, Lond—Jan. 22, 1909. No. 2206 A.

Gas Power.

Some Effects of Gas Power on Tendencies and Development of the National Industry in Germany. Dr. F. E. Junge. A discussion of the effect of electrical energy on the iron and steel industry, and the economy of gas power. 3500 w. Ir Trd Rev—Feb. 25, 1909. No. 2768.

Lubricants.

See Engine Lubrication, under STEAM ENGINEERING.

Lubrication.

The Brady Controllable Level Apparatus for Distributing Liquids. Diagrams and description of this lubricator, and some of its uses. 1200 w. Ir & Coal Trds Rev—Feb. 12, 1909. No. 2598 A.

Shafting.

The Alinement of New and Realinement of Old Shafting. James Lomas. Directions for the erection and alining of shafting. Ills. 1800 w. Power—Feb. 2, 1909. No. 2192.

STEAM ENGINEERING.

Boiler Design.

Computing Boiler Power. Charles L. Hubbard. Gives simple methods for calculating the size of boilers. 1800 w. Elec Age—Feb., 1909. No. 2510.

Tests on Mild Steel Dished Ends. Translation of an article published in *Zeit. des Ver. Deut. Ing.* in Dec., 1899, describing and giving tabulated results of tests. 2000 w. Engr, Lond—Feb. 12, 1909. Serial, 1st part. No. 2701 A.

Boiler Explosions.

The Boiler Explosion at the Laura Mine, Eygelshoven, Holland (Die Dampfkesselexplosion auf der Grube Laura in Eygelshoven, Holland). A. Vierow. Illustrates and describes the explosion and its effects, and discusses its cause. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1909. No. 2843 D.

Boiler Furnaces.

The Problem of Furnace Design for Water-Tube Boilers. Harold V. Coes. Considers how to remedy some of the defects. 2000 w. Power—Feb. 16, 1909. No. 2501.

Boiler Management.

Furnace Control and Boiler Testing (Feuerungskontrolle und Dampfkesseluntersuchung). Herr Maercks. A practical paper on boiler management. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 23, 1909 No. 2838 D.

Boiler Testing.

Recent Refinements in Boiler Testing. Albert A. Cary. Illustrated descriptions of apparatus and methods employed. 5500 w. Power—Feb. 23, 1909. No. 2719.

See also Boiler Management, under STEAM ENGINEERING.

Boiler Theory.

The Transmission of Heat Between Fluids. R. M. Neilson. A scientific discussion giving data that can readily be applied in practice. 3500 w. Engr, Lond—Feb. 12, 1909. No. 2702 A.

The Laws of Heat Transmission in Steam Boilers, as Deduced from Experiment. John T. Nicholson. Read before the Jr. Inst. of Engrs. Describes methods of investigation, discussing results. 4500 w. Mech Engr—Jan. 22, 1909. Serial, 1st part. No. 2212 A.

Boiler Tubes.

The Resistance of Thin Tubes Subjected to External Pressure (Sulla Resistenza dei Tubi a Parete sottile premuti dall' Esterno). G. Rabbeno. Mathematical. Ills. 4000 w Riv Marit—Jan., 1909. No. 2647 E + F.

Boiler Waters.

Boiler Feed-Water and Its Treatment. J. R. Campbell. Discusses waters found in the Pittsburg district and the methods and materials used in treating them. 2800 w. Mines & Min—Feb., 1907. No. 2229 C.

Some Useful Lessons of Limewater. Charles S. Palmer. Hints for boiler room tests. Ills. 3500 w. Power—Feb. 2, 1909. Serial, 1st part. No. 2190.

Condensers.

Development of the Surface Condenser. Warren O. Rogers. Illustrates and describes types, beginning with Watt's, and including the most modern apparatus. 1600 w. Power—Feb. 9, 1909. Serial, 1st part. No. 2379.

We supply copies of these articles. See page 159.

Condensers (Quelques Condenseurs). A review of recent types and recent researches on the influence of vacuum and of circulation on their efficiency. Ills. Serial, 1st part. 5000 w. Rev de Mécan—Jan., 1909. No. 2624 E + F.

The Design of Marine Condenser Plants (Die Konstruktive Ausbildung von Kondensationsanlagen an Bord von Seeschiffen). Hans Vogel. A discussion both theoretical and practical. Ills. Serial, 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 30, 1909. No. 2697 D.

See also Turbines, under STEAM ENGINEERING.

Cooling Towers.

See same title, under HEATING AND COOLING.

Engine Design.

Current Practice in Steam Engine Design. Ole N. Trooien. An investigation of current practice in proportioning steam engine parts, giving formulæ showing the general trend. 5000 w. Bul Univ of Wis, No. 252—Oct., 1908. No. 2735 C.

Offsetting Cylinders in Single-Acting Engines. Prof. Thurston M. Phetteplace. A discussion of the claims of superiority made for this form of condensation. 5500 w. Jour Am Soc of Mech Engrs—Feb., 1909. No. 2406 F.

Engine Efficiency.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engine Foundations.

See Foundations, under CIVIL ENGINEERING, CONSTRUCTION.

Engine Lubrication.

Lubricants for Cylinders. John M. Sewell. Explains the conditions to be met and considers the requisite qualities for cylinder lubrication. 2400 w. Power—Feb. 9, 1909. No. 2378.

Engines.

Modern British High-Speed Steam Engines. John Davidson. Describes current British practice. Ills. 3500 w. Power—Feb. 9, 1909. Serial, 1st part. No. 2376.

Engine Speed.

Piston Speed. Gives a table of actual piston speed, illustrating by example, and explaining method of calculating. 800 w. Mech Wld—Feb. 5, 1909. No. 2480 A.

Engine Theory.

The Function of Compression. R. T. Strohm. Shows that compression in steam engines is not only desirable, but a necessity. 2000 w. Power—Feb. 16, 1909. No. 2502.

Fuel Gas.

See Gas Producers, under COMBUSTION MOTORS.

Fuels.

Coal Specifications and Tests. A. V. Doane. Discusses things to be considered in specifying, methods of sampling and testing, etc. 2500 w. Power—Feb. 2, 1909. No. 2187.

Tests of Coal and Briquets as Fuel for House-Heating Boilers. D. T. Randall. Describes the method of conducting the tests, giving data and results, and conclusions. Ills. 9800 w. U S Geol Surv—Bul. 366. No. 2781 N.

The Temperature Obtainable with Ordinary Fuels (Welche Temperaturen können wir mit unseren gewöhnlichen Brennstoffen erreichen?). Josef v. Ehrenwerth. A mathematical discussion of the chemistry of the combustion of carbonaceous fuels. Serial, 1st part. 1600 w. Oest Zeitschr f Berg- u Hüttenwesen—Jan. 16, 1909. No. 2670 D.

See also Locomotive Fuels, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Indicator Diagrams.

Some Suggestive Indicator Diagrams. W. G. McKellor. Discusses diagrams of a number of engines running from 10 to 30 horsepower. 4000 w. Jour W of Scotland Ir & St Inst—Nov. and Dec., 1908. No. 2431 N.

Mechanical Stokers.

Recent Developments in Machine Stoking. A. W. Bennis. Read before the Bradford Engng. Soc. Considers the best known types of mechanical firing apparatus, their improvements, and the effect of modern requirements. 1200 w. Elect'n, Lond—Feb. 5, 1909. Serial, 1st part. No. 2580 A.

Steam Meters.

Steam Meters (Dampfmesser). F. Bendemann. Illustrated description of various types. Serial, 1st part. 5200 w. Zeitschr d Ver Deutscher Ing—Jan. 2, 1909. No. 2833 D.

Steam Pipes.

Pipe Supports. A. Houlson. Illustrates and describes standard types, and suggestions for their use. 1200 w. Mech Engr—Jan. 22, 1909. No. 2211 A.

High Pressure Steam Piping Systems. William F. Fischer. Notes on recent design, including a discussion of expansion, vibration, pipe and pipe fittings, etc. 4000 w. Power—Feb. 23, 1909. No. 2720.

Improved Coupling for Copper Pipes. Illustrates and describes an improved method invented by William Bryce. 500 w. Engr, Lond—Feb. 12, 1909. No. 2705 A.

See also Copper, under MATERIALS OF CONSTRUCTION; and Valves, under STEAM ENGINEERING.

Steam Properties.

The Total Heat of Saturated Steam.

Dr. Harvey N. Davis' paper is discussed. 5000 w. Jour Am Soc of Mech Engrs—Feb., 1909. No. 2411 F.

Energy in a Pound of Steam. Fred. R. Low. Demonstrates that the net energy of expansion from 150 pounds down to atmospheric pressure approximates energy from atmospheric pressure down to 27½ inches of vacuum. 3000 w. Power—Feb. 2, 1909. No. 2186.

Stoking.

The Skill of Firemen (L'Habilité professionnelle des Chauffeurs). J. Izart. Gives the results of an annual firemen's competition at Lille for six years showing how much firemen may be improved by careful training. 2000 w. L'Elecn—Jan. 9, 1908. No. 2629 D.

Superheaters.

Superheaters. Frank Hugh Preece. Brief discussion of their design and advantages, with illustrated descriptions of the principal types now in use. 3500 w. Inst of Civ Engrs—No. 3719. No. 2790 N.

Turbines.

The Bergmann Steam Turbine. Illustrated description with statement of the advantages claimed. 2000 w. Col Guard—Feb. 5, 1909. No. 2483 A.

The Utilization of Exhaust Steam in Low-Pressure Turbines. R. F. Halliwell. Read before the Rugby Engng. Soc. Discusses the more important features of low-pressure turbine plants, showing the economies that can be effected by their use. 2500 w. Mech Engr—Jan. 29, 1909. Serial, 1st part. No. 2352 A.

The Utilization of Steam in Low-Pressure Turbines (Abdampfverwertung und neuere Abdampfanlagen). Hugo Weinberger. Discusses the energy in exhaust steam and describes a number of low-pressure turbine plants, with data on their economy. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Jan. 1, 1909. No. 2612 D.

Steam Turbines with High Back Pressure (Dampfturbinen mit hohem Gegendruck). H. Wagner. Discusses their operation in a number of cases. Ills. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 9, 1909. No. 2695 D.

Surface Condensation for Steam Turbines. E. Josse. Abstract of paper read before the *Schiffsbautechnische Gesellschaft* at Berlin. Considers the coefficient of heat transference, influence of air leakage, condenser pumps, etc. 3000 w. Power—Feb. 2, 1909. No. 2188.

Valves.

Gate Valves in Steam Pipe Lines. W. H. Wakeman. Practical suggestions for locating and using them. 2000 w. Power—Feb. 16, 1909. No. 2500.

TRANSPORTING AND CONVEYING.

Cableways.

A Travelling Cableway. An interesting cableway recently erected at Grays, in Essex, is illustrated and described. 600 w. Engr, Lond—Feb. 12, 1909. No. 2704 A.

Coal Handling.

An Interesting German Coal Loading Installation. Illustrated description of a travelling crane installed in Emden harbor. 1200 w. Col Guard—Feb. 5, 1909. No. 2484 A.

Coal Shipping Arrangements at St. John's Collieries, Normanton. Illustrated description of arrangements for loading coal into boats at a colliery nearly two miles from a canal wharf. 2500 w. Ir & Coal Trds Rev—Jan. 29, 1909. No. 2372 A.

See also Coal Pockets, under CIVIL ENGINEERING, CONSTRUCTION.

Conveyors.

See Steamships, under MARINE AND NAVAL ENGINEERING.

Cranes.

An Electric Bridge Crane for Handling Ingots (Elektrisch betriebener Bockkran für die Verladung von Ingots). R. Dub. Illustrated detailed description. 2200 w. Zeitschr d Ver Deutscher Ing—Jan. 16, 1909. No. 2837 D.

See also Shop Appliances, under MACHINE WORKS AND FOUNDRIES; and Coal Handling, under TRANSPORTING AND CONVEYING.

Lifting Magnets.

The Industrial Use of the Lifting Magnet. W. Frank M'Clure. Information in regard to the uses to which these magnets are applied, new types, and their operation. Ills. 1500 w. Sci Am—Feb. 6, 1909. No. 2280.

Material Handling.

See Shops, under MACHINE WORKS AND FOUNDRIES.

Ore Handling.

An Ore Handling Plant in New Caledonia. Illustrates and describes a system of suspension trucks and cables for carrying ore, coal, merchandise and passengers. 1500 w. Eng & Min Jour—Feb. 20, 1909. No. 2556.

MISCELLANY.

Aëronautics.

The Present Status of Military Aëronautics. George O. Squier's paper is discussed. 2000 w. Jour Am Soc of Mech Engrs—Feb., 1909. No. 2408 F.

Fundamental Considerations in the Construction of Airships (Konstruktions grundlagen von Flug-Fahrzeugen). Fritz Huth. A theoretical paper. Ills. Serial. 1st part. 2000 w. Motorwagen—Jan. 10, 1909. No. 2802 D.

The Present and Future of Aviation (Etat actuel et Avenir de l'Aviation). Rodolphe Soreau. An exhaustive paper on the theory, design, construction, and

future of aeroplanes. 80000 w. Mem Soc Ing Civ de France—July, 1908. No. 2687 G.

Insufficiency of the Methods Actually Employed for Measuring the Efficiency of Aerial Propellers (Insuffisance des Méthodes employées actuellement pour mesurer le Rendement des Hélices aériennes). Eugène Bolle. Suggests a satisfactory method. 3000 w. Génie Civil—Jan. 2, 1909. No. 2638 D.

See also Exhibitions, under AUTOMOBILES; and Gasoline Engines, under COMBUSTION MOTORS.

Air Resistance.

The Resistance of the Air and M. Eiffel's Recent Investigations (La Résistance de l'Air et les récentes Expériences de M. G. Eiffel). Paul Renard. Describes the experiments carried out at the Eiffel Tower and discusses the significance of the results. Ills. 4000 w. Rev Gen des Sci—Jan. 30, 1909. No. 2627 D.

Safety Devices.

Safety Appliances in German Machine Shops. Illustrated descriptions of simple guards and operating devices to protect workmen. 1200 w. Am Mach—Vol. 32, No. 7. No. 2514.

Textile Mills.

Removal of Dust from Card-Rooms of Cotton Mills. Illustrated description of the "Hall and Kay" method, designed to remove the stripping dust as rapidly as it is produced. Also the design of Herbert Smethurst & Co. 1200 w. Engr, Lond—Jan. 29, 1909. No. 2371 A.

Weighing Machines.

Automatic Weighing Machine. Illustrated description of a battery of Stacey grain weighers and their operation. 1200 w. Engr, Lond—Jan. 22, 1909. No. 2226 A.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Economy as Related to Mine Accidents. H. E. Coll. Discusses lax conditions, showing the heavy cost of neglect. 3500 w. Eng & Min Jour—Feb. 13, 1909. No. 2467.

Alberta.

The Coal Fields of Alberta. D. B. Dowling. Briefly outlines the history of the finding and mapping of the deposits, describing the formations. Map. 3000 w. Ec Geol—Jan.-Feb., 1909. No. 2715 D.

Belgium.

The Campine Coal Basin (Le Bassin houiller de la Campine). A. Ledoux. Report of an extensive study of this newly discovered coal field in northern Belgium. Serial. 1st part. 3000 w. Bul Sci d l'Assn des Elèves—Dec., 1908. No. 2600 D.

Colorado.

The Delagua Mines of the Victor Fuel Co. F. W. Whiteside. Describes an adaptation of surface arrangements to suit peculiar topography and location of mine openings. Ills. 2000 w. Mines & Min—Feb. 1, 1909. No. 2231 C.

Explosions.

Prevention of Mine Explosions. James Ashworth. Reviews the report by the foreign experts who visited the United States by invitation of the Government. 1700 w. Mines & Min—Feb., 1909. No. 2233 C.

Mine Explosions as Related to Earthquakes. W. A. Spalding. A discussion favoring the theory that the danger from explosions in deep mines is augmented during periods of seismic disturbance. 2500 w. Eng & Min Jour—Feb. 20, 1909. No. 2560.

Explosives.

The Prevention of Mining Accidents. Brief illustrated description of the United States experiment station at Pittsburg, Pa. 1000 w. Sci Am Sup—Feb. 20, 1909. No. 2529.

Tests of Safety Explosives (Versuche mit Sicherheitsprengstoffen). Herr Beyling. Gives results of tests on a large number of German explosives. 4500 w. Glückauf—Jan. 23, 1909. No. 2677 D.

Formation.

Pressure in the Formation and Alteration of Coal. D. B. Dowling. Gives results of recent experiments on peat, showing that there is some relation between the pressure under which the coal was formed and the resultant compound. 1400 w. Can Min Jour—Feb. 15, 1909. No. 2550.

Mining.

Mining Methods for Maximum Recovery of Coal. H. V. Hesse. Considers the important factors that cause loss, discussing improved methods of operation, giving a case where early methods secured about 50% and present methods 95%. Ills. 4000 w. Eng & Min Jour—Feb. 6, 1909. No. 2318.

New Zealand.

Coal-Mining Methods in New Zealand. Frank Reed. An account of methods of operating, ventilation, prospects, etc. 1500 w. N Z Mines Rec—Dec. 16, 1909. No. 2199 B.

Coal Mining Methods in New Zealand.

Frank Reed. Brief description of coal-mining operations, colliery workings, etc. 2000 w. Aust Min Stand—Jan. 13, 1909. No. 2506 B.

Pennsylvania.

The Jenner Mine of the Somerset Coal Co. John L. Wagner. Illustrated description of the ring electric coal puncher machines for cutting coal, methods of haulage, etc. 1400 w. Mines & Min—Feb., 1909. No. 2232 C.

Philippines.

Philippine Coal-Fields. J. B. Dilworth. Information concerning the coalfields examined. Map. 4000 w. Bul Am Inst of Min Engrs—Jan., 1909. No. 2422 F.

Philippine Coals as Fuel. Alvin J. Cox. Reports an investigation made to determine the steam-making value of the coals of the Philippine Islands, as compared with foreign coals offered on the market. Also a comparative study of the individual coals. Ills. 12600 w. Philippine Jour of Sci—Nov., 1908. No. 2709 N.

Screening.

Colliery Screening Plant. Arthur Hall. Read before the Nat. Assn. of Col. Mgrs. Describes the general schemes of screening plants, with remarks on things to be adopted or avoided. Ills. 6000 w. Ir & Coal Trds Rev—Feb. 5, 1909. No. 2494 A.

Storage.

The Economy of Storing Coal under Water (Die Lagerung von Steinkohle unter Wasser und die Wirtschaftlichkeit dieses Verfahrens). Kurt Seidl. Discusses the deterioration of coal in air and reports researches on the economy of water storage. Ills. Serial. 1st part. 8800 w. Glückauf—Jan. 9, 1909. No. 2676 D.

Washing.

The Cardiff Coal Washery. Illustrated detailed description of the plant and its operation. 4500 w. Col Guard—Jan. 29, 1909. No. 2356 A.

COPPER.

Arizona.

Historical Résumé of the Copper Queen Mine. Synopsis of an address delivered at Bisbee by Dr. James Douglas, giving the early struggles of this valuable mine. 2500 w. Eng & Min Jour—Feb. 20, 1909. No. 2559.

Assaying.

See Mine Sampling, under MINING.

Blowers.

The Rotary Blower in Smelting Works. George C. Hicks, Jr. Explains the principles of operation and the essentials of success. Ills. 3000 w. Eng & Min Jour—Feb. 13, 1909. No. 2466.

British Columbia.

Methods of Mining the Granby Orebodies. C. M. Campbell. Explains the nature of the deposit, scheme of operations, etc. Little timbering is required, and electric power is used. Ills. 4000 w. Eng & Min Jour—Jan. 30, 1909. No. 2174.

Canada.

Some Recollections of Early Copper Mining in Canada. Dr. James Douglas. Brief review. 1500 w. Can Min Jour—Feb. 1, 1909. No. 2293.

Refining.

The Effect of the Presence of Certain "Addition-Agents" Upon the Density and Coherence of Electrolytically Deposited Copper, Lead, and Silver. Royal P. Jarvis and Edward F. Kern. Based on an investigation conducted in the metallurgical laboratory of the School of Mines, Columbia University. 7000 w. Sch of Mines Qr—Jan., 1909. No. 2752 D.

See also Gold Separation, under GOLD AND SILVER.

Siberia.

See same title, under GOLD AND SILVER.

Smelters.

The Steptoe Valley Smelting Plant, McGill, Nev. Llew. Humphreys. Illustrated detailed description of a plant in course of construction. 2500 w. Min Wld—Feb. 6, 1909. No. 2323.

Smelting.

Success of the Fink Process. Brief account of the successful test made of Edward Fink's invention at Garfield, Utah, which demonstrated its ability to make high grade copper matte, and blister copper. 1200 w. Min Jour—Feb. 6, 1909. No. 2482 A.

Trade.

Production and Prospects in the Copper-Mining Industry. Arthur Selwyn-Brown. Reviews the present position of the copper industries and outlines conditions in the principal copper mining fields. 3000 w. Engineering Magazine—March, 1909. No. 2788 B.

Utah.

The Ohio Copper Company, Bingham, Utah. Jas. MacFarlane. An illustrated article giving the history, geology, development, and other information. 2500 w. Min Wld—Feb. 20, 1909. No. 2574.

GOLD AND SILVER.

Alluvials.

See Australia, under GOLD AND SILVER.

Assaying.

Routine Assaying on a Westralian Mine. W. B. Blyth. Describes some present day Westralian practice. 3800 w. Jour Chem, Met. & Min Soc of S Africa —Dec., 1908. No. 2706 E.

Australia.

Deep-Lead Alluvial Mining in Victoria. Frank Reed. Illustrated description of methods. Plates. 2000 w. N Z Mines Rec—Dec. 16, 1908. No. 2198 B.

The Bendigo Goldfield, Victoria. Frank Reed. Describes the mining operations in the deepest auriferous quartz-mines in the world. 2000 w. N Z Mines Rec—Dec. 16, 1908. No. 2197 B.

The New Loch Fyne Gold Mine, Matlock (V.). James Trevor. Plans and description of operations and general conditions. 1500 w. Aust Min Stand—Dec. 23, 1908. No. 2196 B.

Bolivia.

See Hydraulic Mining, under GOLD AND SILVER.

Colombia.

Gold Mining in Colombia. F. Lynwood Garrison. Describes the geological conditions, especially of the Cauca Valley, and predicts the development of a valuable gold mining country. Ills. 4500 w. Min & Sci Pr—Feb. 6, 1909. No. 2446.

Colorado.

The Alice Mine. R. L. Herrick. An account of a body of porphyry carrying an average of $3 to $4 in gold and silver per ton, in the Fall River District of Colorado. Ills. 3300 w. Mines & Min—Feb., 1909. No. 2228 C.

Cyaniding.

The Use of Lime and Increased Temperatures in Cyanidation. Leo D. Bishop. Abstract of a paper before the Colo. Sci. Soc. Deals with special features of the cyanide process. Ills. 2500 w. Elec Chem & Met Ind—Feb., 1909. No. 2195 C.

The Electrochemistry of Gold Cyanide Solutions. John B. Ekeley and Arthur L. Tatum. Abstract of a paper read before the West. Assn. Tech. Chem. & Met. 1200 w. Min Wld—Feb. 20, 1909. No. 2576.

Cyaniding Operations in Mexico During 1908. Mark R. Lamb. Illustrates a number of plants and reviews the progress during the year. 2500 w. Min Wld—Feb. 6, 1909. No. 2322.

Germany.

See same title, under LEAD AND ZINC.

Gold Separation.

The Pearce Gold-Separation Process. Harold V. Pearce. Gives the history of the development with a description of this process. 4000 w. Bul Am Inst of Min Engrs—Feb., 1909. No. 2749 C.

Hydraulic Mining.

Hydraulic Engineering in the Yukon. E. W. Hagarty. An illustrated article describing the engineering development of the Yukon Gold Co. 4000 w. Can Engr—Feb. 19, 1909. No. 2573.

Suchez de Bolivia Hydraulic Mine. W. E. Gordon Firebrace. Illustrated description of the largest known auriferous gravel deposit in South America. 1000 w. Min & Sci Pr—Feb. 20, 1909. No. 2764.

Nevada.

Mining at Grace Valley and Nevada City. G. E. Wolcott. Inclined shafts are used. Ills. 1800 w. Eng & Min Jour—Feb. 20, 1909. No. 2557.

Mining and Milling at Rawhide, Nevada. G. E. Wolcott. An illustrated account of these gold mines, which give promise of becoming large producers. 3000 w. Eng & Min Jour—Feb. 13, 1909. No. 2464.

Ore Formation in the Wonder District, Nevada. Etienne A. Ritter. Map and illustrated description of the vein structure, and peculiar arrangement of the silver and gold minerals. 1500 w. Eng & Min Jour—Feb. 6, 1909. No. 2315.

North Carolina.

The Progress of Gold Mining in North Carolina. Edward West Lyon. Reviews the history of mines that were large producers before the Civil War, and are being re-opened. Ills. 4500 w. Eng & Min Jour—Feb. 6, 1909. No. 2316.

Nova Scotia.

Leipsigate Gold Mining District, Nova Scotia. Phil. H. Moore. Illustrated description of this district, its development, and production. 3000 w. Min Wld—Feb. 13, 1909. No. 2442.

Siberia.

Mining in Siberia. Chester W. Purington. Information concerning the Siberian goldfields, and the copper and silver-lead deposits. 1500 w. Min & Sci Pr—Feb. 13, 1909. No. 2535.

Silver Refining.

See Refining, under COPPER.

Wales.

See same title, under LEAD AND ZINC.

Yukon.

See Hydraulic Mining, under GOLD AND SILVER.

IRON AND STEEL.

Bessemer Process.

Experimental Researches on the Basic Bessemer Process (Experimentelle Untersuchung des Thomasprozesses). A review of extensive researches giving results. Ills. 8200 w. Stahl u Eisen—Jan. 27, 1909. No. 2665 D.

The New Basic Bessemer Plant at the Burbach Ironworks (Das neue Thomasstahlwerk der Burbacher Hütte). F. Schroeder. Illustrated detailed description. Serial, 1st part. 2000 w. Giesserei-Zeit—Jan. 1, 1909. No. 2682 D.

The New Basic Bessemer Plant at the Burbach Iron Works (La nouvelle Aciérie Thomas des Usines métallurgiques de Burbach, Prusse rhénane). Illustrated description translated from *Stahl und Eisen* for Nov. 11, 1908. 3500 w. Génie Civil—Jan. 2, 1909. No. 2637 D.

Blast-Furnace Design.

A Revolutionary Proposal in Blast Furnace Construction. Describes a proposed

construction of iron blast furnace using blast with an excess of oxygen. Ills. 1500 w. Ir Age—Feb. 11, 1909. No. 2387.

Blast-Furnace Fuels.

The Development of the Use of Coke as a Blast-Furnace Fuel in Germany (Die Entwicklung der Roheisenherstellung mit Koks in Deutschland). Fritz W. Lürmann. A historical review. 6000 w. Stahl u Eisen—Jan. 20, 1909. No. 2662 D.

Blast-Furnace Gas.

See Blowing Engines, under IRON AND STEEL.

Blowing Engines.

Blast Furnace Gas Blowing Engine. Drawings and illustrated description of a 1100-B.H.P. engine for the Barrow Hematite Iron & Steel Co., Ltd. 1800 w. Engr, Lond—Feb. 5, 1909. No. 2491 A.

China.

Steel Making in China. Theodore D. Morgan. Information concerning the works at Hankow, their labor conditions and iron ore and fuel supplies. 3000 w. Ir Age—Feb. 4, 1909. No. 2247.

Gayley's Invention of the Dry Blast. R. W. Raymond. Discusses the value of this invention, the commercial economy, etc. 3500 w. Bul Am Inst of Min Engrs —Jan., 1909. No. 2425 F.

The Use of the Dry-Air Blast for Blast Furnaces (Ueber Anwendung getrockneter Gebläseluft im Hochofenbetrieb). J. Bartel. Reviews experience at the Creusot works, France. Ills. Serial, 1st part. 2200 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 2, 1909. No. 2669 D.

Electro-Metallurgy.

Notes on Iron and Steel. Bradley Stoughton. Discusses briefly the electrothermic manufacture of iron and steel, and the properties and uses of alloy steels. Ills. 3000 w. Jour Fr Inst—Feb., 1909. No. 2740 D.

The Gröndal-Kjellin and Röchling-Rodenhauser Electric Steel Furnaces. An illustrated account of experimental work. 3000 w. Engng—Jan. 22, 1909. No. 2220 A.

The Keller Process for Producing Steel in the Electric Furnace (La Fabrication électrique des Aciers par le Procédé Ch. A. Keller). Describes the furnace and the various installations. Ills. 2000 w. Rev d'Electrochim et d'Electrométal—Dec., 1908. No. 2612 F.

Ingot Compression.

The Harmet Process for the Compression of Steel Ingots (Développement du Procédé de Compression de l'Acier par Tréfilage). F. Beutter. Describes the development of the process and some of the more important installations in which it is used. Ills. 3000 w. Rev de Métal —Jan., 1909. No. 2617 E + F.

5000-Ton Press for Dynamic Compression of Fluid Steel. Illustrated detailed description of press used in making ingots on the dynamic-compression system. Plate. 2000 w. Engng—Jan. 22, 1909. No. 2217 A.

Minnesota.

Open-Pit Iron Mining on the Mesabi Range of Northern Minnesota. J. Fred Wolff. Outlines the engineering steps in developing an open-pit mine. Ills. 3000 w. Mines & Min—Feb., 1909. No. 2227 C.

Newfoundland.

Sinking of Wabana Submarine Slopes. R. E. and A. R. Chambers. An account of these submarine areas, recent investigations having proven an enormous field of iron ore under Conception Bay. Ills. Plates. 3500 w. Can Min Jour—Feb. 15, 1909. No. 2552.

Ontario.

Recent Progress in the Mineral Industry in the Thunder Bay and Rainy River Districts. F. Hille. Gives a brief résumé of their history and a review of the past year. 2500 w. Can Min Jour—Feb. 15, 1909. No. 2553.

Open Hearth.

See Foundry Furnaces, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Rolling Mills.

Experiments with Rolling Mill Plant. F. Carleton Anderson. Abstract of paper read before the Manchester Assn. of Engrs. A report of experiments made to determine the actual power required for driving a similar mill electrically. 1500 w. Mech Engr—Jan. 29, 1909. Serial, 1st part. No. 2353 A.

Report of the Commission of Research on the Power Consumption of Rolling Mills (Bericht über die Arbeiten der Kommission zur Ermittlung des Kraftbedarfs an Walzwerken). H. Ortmann. Report of tests made by a committee of the Verein deutscher Eisenhüttenleute. Ills. 11000 w. Stahl u Eisen—Jan. 6, 1909. No. 2658 D.

See also Sheets, under IRON AND STEEL.

Sheets.

Power Consumption in Rolling Thin Sheets (Sur le Travail dépensé dans le Laminage de la Tole mince). M. de Loisy. Gives results of tests recently made in a large sheet mill. Ills. 2500 w. Rev de Métal—Jan., 1909. No. 2616 E + F.

Steel Making.

The Manufacture of Steel for Castings. Bradley Stoughton. From a paper read before the Phila. Found. Assn. Compares the various processes as to equipment, quality and cost. 3000 w. Ir Age—Feb. 11, 1909. No. 2385.

We supply copies of these articles. See page 159.

Steel Works.

See Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

LEAD AND ZINC.

Australia.

See Lead Milling, under ORE DRESSING AND CONCENTRATION.

Germany.

Mining in the Harz. Editorial review of metal mining in this district. 2000 w. Engng—Feb. 12, 1909. No. 2596 A.

Lead Refining.

See Refining, under COPPER.

Missouri.

See Ore Deposits, under MISCELLANY.

Tennessee.

The East Tennessee Zinc Mining District. Samuel W. Osgood. Illustrates and describes the mines and deposits, which are too low-grade for small operations. 2500 w. Eng & Min Jour—Feb. 20, 1909. No. 2558.

Wales.

Flintshire District. H. L. Terry. Information concerning the silver-lead mines and spelter works. 1700 w. Min Jour—Feb. 13, 1909. No. 2589 A.

Zinc Recovery.

The Electrolytic Recovery of Zinc. Walther Stoeger. Briefly reviews the new methods of extraction that have been tried for zinc ores, describing a sulphuric acid process that has stood the test of practical application. 1200 w. Min Jour—Jan. 30, 1909. Serial, 1st part. No. 2355 A.

The Electrolytic Recovery of Zinc (Elektrolytische Zinkgewinnung). Walther Stöger. A brief review of recent progress. Ills. 2400 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 2, 1909. No. 2668 D.

Zinc Smelting.

The Central Zinc Company's Works at Seaton Carew. Illustrated detailed description of extensive new works on the N. E. Coast of England. Plate. 2500 w. Engng—Jan. 29, 1909. No. 2358 A.

MINOR MINERALS.

Aluminium.

The Production of Aluminium and its Industrial Applications (Die Herstellung des Aluminiums und dessen industrielle Verwendung). Herr Goldberg. Its reduction from ore, its properties, alloys, uses, etc. Serial, 1st part. 1500 w. Giesserei-Zeit—Jan. 1, 1909. No. 2684 D.

Carborundum.

Carborundum (Le Carborundum). L. Baraduc-Muller. An exhaustive review of its discovery, manufacture, properties and uses. Ills. 19000 w. Mem Soc Ing Civ de France—Nov., 1908. No. 2602 G.

Cement.

Volcanic Tuff as a Construction and a Cement Material. Alvin J. Cox. A report of tests made to show its real value. 3000 w. Philippine Jour of Sci—Nov., 1908. No. 2710 N.

The Tonto Portland Cement Works, at Roosevelt Dam, Arizona. Edgar Percival. Illustrated description of this plant constructed to supply the dam works, with features of the manufacture and statement of cost. 2000 w. Munic Engng—Feb., 1909. No. 2333 C.

Clay.

Our Visible Supply of Brick. M. B. Baker. Describes the clay deposits of Eastern Canada. 2800 w. Can Min Jour—Feb. 15, 1909. No. 2549.

Manganese.

The Manganese Ore Deposits of Georgia. Thomas L. Watson. A study of the distribution, origin, etc. 3500 w. Ec Geol—Jan.-Feb., 1909. No. 2718 D.

Natural Gas.

The Natural Gas Situation at Huntsville, Ala. John R. Lynn. Aims to give a true statement of what is known of this field. 3000 w. Am Gas Lgt Jour—Feb. 8, 1909. No. 2312.

Nickel.

A New Method for the Determination of Nickel in the Presence of Cobalt (Nuevo Procedimiento para el Dosaje del Niquel en Presencia del Cobalto). Juan A. Sánchez. A technical description of the method. 4000 w. Anales d l Soc Cien Argentina—Oct., 1908. No. 2657 E + F.

Oil.

Petroleum in 1908 Largest Production on Record. David T. Day. Reports the production from the different fields. 3500 w. Min Wld—Feb. 6, 1909. No. 2324.

Salt.

The Geological Occurrence of Rock Salt in Louisiana and East Texas. G. D. Harris. Describes these deposits and their origin. Maps. 6500 w. Ec Geol—Jan.-Feb., 1909. No. 2716 D.

Slate.

Welsh Slate and the Penrhyn Quarry. Lionel C. Ball. Brief illustrated account of the methods at the largest slate quarry in the world. 3000 w. Queens Gov Min Jour—Jan. 15, 1909. No. 2503 B.

Sulphur.

Makushin Sulphur Deposits, Unalaska. N. Oliver Lawton. Describes the deposits of this volcanic region. Ills. 1800 w. Min & Sci Pr—Feb. 13, 1909. No. 2536.

Tin.

Recovery of Tin from Alluvial Deposits. H. G. Trenchard. Notes on steam

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sluicing plants at Tingha (N. S. W.) 3000 w. Aust Min Stand—Jan. 13, 1909. No. 2505 B.

MINING.

Accidents.

Prevention of Accidents in Metal Mines. Claude T. Rice. Calls attention to many preventable accidents due to carelessness. 6500 w. Eng & Min Jour—Feb. 6, 1909. No. 2317.

Accounting.

Mine Accounting. John G. Grant. The first of a series of articles dealing with book-keeping for mining companies. 2500 w. Can Min Jour—Feb. 15, 1909. Serial, 1st part. No. 2551.

Mine Accounting in the Ruhr District (Die im Ruhrbergbau üblichen Methoden der Selbstkostenberechnung). Herr Reckmann. An exhaustive description of the cost keeping methods in this coal district. Ills. Serial, 1st part. 6000 w. Glückauf—Jan. 2, 1909. No. 2675 D.

Blasting.

The Theory of Blasting with High Explosives. Interesting contributions to the discussion of E. M. Weston's paper. 9500 w. Jour Chem Met & Min Soc of S Africa—Dec., 1908. No. 2708 E.

Electric Shot-Firing in Coal Mines. D. Harrington. Discusses a system installed in Utah where all shots are fired from the surface after the workings are clear of men. Ills. 4000 w. Eng & Min Jour—Jan. 30, 1909. No. 2172.

Boring.

Prospect Drilling in the Joplin District, Missouri. Doss Brittain. An account of prospecting with the churn drill. 2200 w. Min Wld—Feb. 13, 1909. No. 2443.

Electric Power.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Hoisting.

The Lubrication of Winding Ropes and Cage Guides (Neuerungen bei der Förderseil und Spurlattenschmierung). O. Dobbelstein. Illustrates and describes recent oiling devices. 2000 w. Glückauf—Jan. 2, 1909. No. 2674 D.

Devices for Greasing Winding Ropes and Cage Guides. O. Dobbelstein, in *Glückauf*. Illustrated detailed description. 1200 w. Col Guard—Jan. 29, 1909. No. 2357 A.

Hoisting Engines.

A New Safety Device for Steam Hoisting Engines (Eine neue Sicherheitsvorrichtung für Dampffördermaschinen). G. Schönfeld. Illustrated detailed description of an automatic stop. 2200 w. Glückauf—Jan. 23, 1909. No. 2678 D.

The Debauche Light Automatic Brake for Hoisting Engines (Frein léger à Action variable applicable aux Machines d'Extraction). Illustrated detailed description. 2000 w. Rev de Mécan—Jan., 1909. No. 2625 E + F.

See also Machinery, under MINING.

Machinery.

The Management of Mining Machinery (Maschinenwirtschaft in Bergwerken). H. Hoffmann. Discusses the installation, operation, and care of pumping, hoisting, compression and other machinery. Ills. Serial, 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Jan. 2, 1909. No. 2832 D.

Management.

A Labor Chart for the Management of Mining and Milling Operations. Joseph Macdonald. Gives the labor chart used for the Guanajuato Consolidated Mining & Milling Co., with explanatory notes. 900 w. Bul Am Inst of Min Engrs—Jan., 1909. No. 2424 F.

Mine Sampling.

Sampling and Assaying the Copper Ores of the Ely District. Robert Marsh, Jr. On the value and cost of drilling work in developing low-grade ores. 2000 w. Sch of Mines Qr—Jan., 1909. No. 2751 D.

Development Sampling and Ore Valuation of Gold Mines. C. Baring Horwood. Calls attention to the essential features of good practice. 3000 w. Bul Am Inst of Min Engrs—Jan., 1909. No. 2426 F.

Mine Valuation.

See Mine Sampling, under MINING.

Ore Handling.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Prospecting.

See Boring, under MINING.

Pumping.

The Choice of Mine Pumps (Ueber die Auswahl unterirdischer Wasserhaltungen). P. Hartmann. Discusses the cost and efficiency of electrically and steam driven plunger and centrifugal pumps. Ills. 4500 w. Glückauf—Jan. 30, 1909. No. 2679 D.

Quarrying.

See Slate, under MINOR MINERALS.

Shaft Sinking.

Shaft Sinking at the Horden Colliery, Southeast Durham. John Joseph Prest. Describes the work incidental to the sinking of three shafts through water-bearing strata. Ills. Discussion. 13500 w. Inst of Civ Engrs—No. 3708. No. 2796 N.

Sinking a Wet Shaft at Tombstone. Elton W. Walker. An account of sinking through the largest continuous flow of water ever dealt with. Ills. 1200 w. Min & Sci Pr—Feb. 20, 1909. No. 2763.

Timbering.

An Improved Method of Timbering Workings. Martin Schwerin. Diagrams

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and description of a method involving stoping by successive inclined sluices and filling in the spaces as the work progresses. 1200 w. Min Wld—Feb. 6, 1909. No. 2325.

Tonnage Computation.

Computing Tonnage from Volume of Ore Removed. S. L. Lefevre and Guy C. Stoltz. Explains method followed to determine the tonnage of ore extracted in any trespass, where two companies work together harmoniously. Plan. 800 w. Eng & Min Jour—Feb. 13, 1909. No. 2465.

Ventilation.

Problems of Mine Ventilation: Gas Caps of Inflammable Gas. Abstract of the lecture of W. H. Hepplewhite at Nottingham University. 5500 w. Ir & Coal Trds Rev—Feb. 12, 1909. No. 2599 A.

Pressure Fans vs. Exhaust Fans. Audley H. Stow. Their application to colliery ventilation, giving arguments for and against each form of ventilation, considering their weight and bearing. 4500 w. Bul Am Inst of Min Engrs—Feb., 1909. No. 2750 C.

ORE DRESSING AND CONCENTRATION.

Crushing.

See Gold Milling, under ORE DRESSING AND CONCENTRATION.

Gold Milling.

Grading Assays and Grinding Efficiencies. Arthur Yates. Discusses the value of grading analyses in connection with estimating crushing efficiency, and also as a method of checking extraction results. 2000 w. Jour Chem, Met & Min Soc of S. Africa—Dec., 1908. No. 2707 E.

Ore Washing at Cripple Creek. Describes the ore deposits, methods of screening and washing. 2000 w. Min & Sci Pr—Feb. 20, 1909. No. 2766.

See also Nevada, under GOLD AND SILVER.

Iron.

Hand Sorting and Mechanical Dressing of the Dillenburg Red Ironstone (Ueber Handscheidung und mechanische Aufbereitung des Roteisensteins im Dillenburgischen). Herr Eickhoff. The ores are concentrated by classifying and jigging. Ills. 2500 w. Stahl u Eisen—Jan. 20, 1909. No. 2663 D.

Launders.

The Carrying Capacity of Launders. W. C. Browning. Gives results of experiments at the Utah State School of Mines, with launders of glass, wood and linoleum at different grades. 1700 w. Mines & Min—Feb., 1909. No. 2230 C.

Lead Milling.

Treatment of Broken Hill Ores. W. Poole. Read before the Sydney Univ. Engng. Soc. Detailed description of the concentration of these complex lead-zinc ores. 6800 w. Queens Gov Min Jour—Jan. 15, 1909. Serial, 1st part. No. 2504 B.

Magnetic Concentration.

The Grondal Method of Concentrating Ore. N. U. Hansell. A description of the wet magnetic methods and apparatus employed in Sweden and other European countries. Ills. 2200 w. Ir Trd Rev—Feb. 11, 1909. Serial, 1st part. No. 2440.

Mill Management.

See Management, under MINING.

Roasting.

See Calcium Sulphate, under MISCELLANY.

Sampling.

The Methods of the United States Steel Corporation for the Commercial Sampling and Analysis of Iron Ores. J. M. Camp. Explains methods. 10000 w. Elec Chem & Met Ind—Feb., 1909. No. 2194 C.

Zinc Milling.

See Lead Milling, under ORE DRESSING AND CONCENTRATION.

MISCELLANY.

Alaska.

Progress in Alaska. Alfred H. Brooks. Reviews the production for 1908, and discusses some of the causes that are retarding the mineral industry. 1500 w. Min & Sci Pr—Jan. 30, 1909. No. 2292.

Austria.

Mining in the Austrian Alps (Montanistische Streifzüge durch die Alpenländer). Alfons Müllner. A description of the mining and smelting industries. Ills. Serial, 1st part. 3500 w. Oest Zeitschr f Berg u Hüttenwesen.—Jan. 30, 1909. No. 2672 D.

British Columbia.

Southeastern British Columbia. J. A. Ohren. A résumé of the mining industry for the year 1908. 3500 w. Can Min Jour—Jan. 1, 1909. No. 1459.

Mineral Production of British Columbia in 1908. E. Jacobs. Reports a decrease of over $2,000,000 in total value, with an increase in lode gold, copper, silver and zinc. 5000 w. Eng & Min Jour—Jan. 30, 1909. No. 2173.

Calcium Sulphate.

The Behavior of Calcium Sulphate at Elevated Temperatures with Some Fluxes. H. O. Hofman and W. Mostowitsch. An account of an investigation to study the behavior of gypsum when exposed to elevated temperatures, both alone and in the presence of fluxes. 7300 w. Bul Am Inst of Min Engrs—Jan., 1909. No. 2423 F.

Colorado.

Colorado in 1908. Forbes Rickard. A review of the history of mining and met-

allurgical industries during the year, showing progress in the face of adverse conditions. Ills. 1200 w. Min & Sci Pr—Jan. 2, 1909. No. 1629.

Mexico.

A Brief Review of the Mining Industry of Mexico. Ezequiel Ordoñez. An account of mining conditions. 4000 w. Ec-Geol—Dec., 1908. No. 1875 D.

Nevada.

Nevada in 1908. J. H. G. Wolf. A review of the mining industry during the past year. 3500 w. Min & Sci Pr—Jan. 2, 1909. No. 1626.

New Zealand.

New Zealand as a Mining Country. James Mackintosh Bell. Map and illustrated discussion of the possibilities, reviewing important mines. 4000 w. Aust Min Stand—Nov. 25, 1909. No. 1687 B.

Nova Scotia.

The Minerals of Nova Scotia During 1908. A. S. Barnstead. A review of the production of coal, gold, iron, gypsum, and other minerals. 2500 w. Can Min Jour—Feb. 1, 1909. No. 2294.

Ore Deposits.

A Theory of Volcanic Action and Ore Deposits. Their Nature and Cause. Hiram W. Hixon. The basis of the theory is that the earth was at one time an incandescent sun. Applies the law of diffusion of gases. 5000 w. Inst of Min & Met, Bul 52—Jan. 14, 1909. No. 2427 N.

An Instance of Secondary Impoverishment. Henry Hobart Knox. Describes an occurrence of unoxidized iron sulphides which have been leached of their copper contents. 3500 w. Inst of Min & Met, Bul 52—Jan. 14, 1909. No. 2428 N.

The Many Varied Occurrences of Ore in Veins. Arthur Lakes. Illustrates and describes some of the common variations. 1500 w. Min Wld—Feb. 20, 1909. No. 2575.

The Silver Islet Vein, Lake Superior. Walter McDermott. Reprint of an article published in 1877 which describes ore deposits of interest in connection with the present experience of mining at Cobalt. 5000 w. Inst of Min & Met, Bul 52—Jan. 14, 1909. No. 2429 N.

Ozark Lead and Zinc Deposits: Their Genesis, Location, and Migration. Charles R. Keyes. Outlines the principal hypotheses advanced to explain their origin, the geology of the formations, geographic distribution, and a study in general of the salient features. Ills. 14500 w. Bul Am Inst of Min Engrs—Feb., 1909. No. 2748 D.

The Formation of Specular Iron Ore (Zur Bildung von Eisenglanz). H. Wölbling. Describes the chemical actions necessary to produce this mineral. 2600 w. Glückauf—Jan. 2, 1909. No. 2673 D.

Experiments on the Separation of the Constituents of a Solution by Filtration Through a Mineral Filter. Eugene C. Sullivan. Describes experimental work at the chemical laboratory of the U. S. Geol. Survey. 2000 w. Ec-Geol—Dec., 1908. No. 1879 D.

Reviews of 1908.

Review of Mining in the United States in 1908. The various mining districts are reviewed by different authors. 88000 w. Min Wld—Jan. 30, 1909. No. 2185.

Profits of American Mines in 1908. Editorial, showing that in spite of adverse conditions the sum of $51,581,092 was paid to shareholders. Also progress and improvements during the year. 4000 w. Min Wld—Jan. 30, 1909. No. 2184.

The Metals in 1908. A review of the past year in connection with the markets. Copper and tin are considered in this number. 4000 w. Min Jour—Jan. 23, 1909. Serial, 1st part. No. 2215 A.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Signalling.

Railway Signaling. James B. Latimer. An elementary explanation of the uses of the various signals, the principles of the track circuit, etc. 2500 w. Sig Engr—Feb., 1909. Serial, 1st part. No. 2540.

Track Circuit Signals Without Insulated Joints. Describes this system which has been in use on the Long Island Railroad for six months. Ills. 1200 w. R R Age Gaz—Feb. 12, 1909. No. 2472.

Difficulties With Track Circuits in Great Britain. From the report of Ames and Adams, Interstate Commerce Commission. Explains some difficulties not encountered in American practice. 800 w. R R Age Gaz—Feb. 19, 1909. No. 2548.

Experiments with Safety Appliances for Preventing Trains from Over-Running Signals Standing at "Danger." Capt. Gonell. Describes appliances under trial by the Prussian State Railways. Ills. 4000 w. Bul Int Ry Cong—Jan., 1909. No. 2435 G.

First Annual Report of the Block Signal and Train Control Board to the Interstate Commerce Commission. 24000 w. Sig Engr—Feb., 1909. No. 2541.

The Perry-Prentice Wireless Signalling System. H. Avery Blair. Illustrated de-

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tailed description of this system. 4500 w. Sig Engr—Feb., 1909. No. 2539.

New Interlocking Work on the Baltimore & Ohio R. R. Describes special features of recently installed plants. Ills. 1500 w. Ry & Engng Rev—Jan. 30, 1909. No. 2182.

New Automatic Signals on the Boston & Albany. Illustrated description of a recent installation of the Hall automatic block signals, between Westfield, Mass., and Rensselaer, N. Y. 1200 w. R R Age Gaz—Feb. 5, 1909. No. 2299.

Manual Block Signaling with the "A B C" System on Northern Pacific. Gives some details of the Northern Pacific practice and a comparison between the Alfred Beamer plan and other methods of train control. 3500 w. R R Age Gaz—Feb. 19, 1909. Serial, 1st part. No. 2543.

Railway Signalling in Holland, Belgium, Switzerland, and Italy (Notes sur la Signalisation des Chemins de Fer—Hollande, Belgique, Suisse, Italie). Ed. Epinay. An exhaustive review of signal practice in these countries. Ills. 34000 w. Ann d Ponts et Chauss—1908-II. No. 2606 E + F.

Train Operation.

Military Habits in Train Operation. W. L. Park. Especially considers the importance of efficient flagging of trains. 2000 w. R R Age Gaz—Feb. 19, 1909. No. 2544.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Continuous Brakes on Good Trains. J. Doyen. Gives statistical information based on a paper by Mr. Staby. 1800 w. Bul Int Ry Cong—Jan., 1909. No. 2432 G.

Vacuum Brake Trials. Reports trials of the Hardy system on the lines of the Austrian state railways. Six tables. 4000 w. Bul Int Ry Cong—Jan., 1909. No. 2433 G.

Broken Air Pipes with H. 6 Brake. G. W. Kiehm. Directions for various possible breaks. 2000 w. Ry & Loc Engng—Feb., 1909. Serial, 1st part. No. 2266 C.

Axles.

A Differential Joint for Railway Car Axles. Illustrated description of a device for jointing railway car axles to permit independent rolling of the two wheels. 900 w. Eng News—Feb. 4, 1909. No. 2278.

Brake Shoes.

Brake Shoe Testing Machine. Illustrated description of a machine by which brake shoes may be tested under conditions similar to actual service. 1200 w. R R Age Gaz—Feb. 26, 1909. No. 2778.

Dynamometer Cars.

Dynamometer Car of the University of Illinois and the Illinois Central Railroad. F. W. Marquis. Illustrated description of the newly equipped car and its records. 3000 w. R R Age Gaz—Feb. 19, 1909. No. 2545.

Electrification.

Railway Electrification. Philip Dawson. Briefly considers a few advantages in the case of long-distance lines, especially discussing the advantages to British railways by the electrification of suburban lines. 3000 w. Elec Rev, Lond—Feb. 5, 1909. Serial, 1st part. No. 2476 A.

Electric Traction on Urban and Interurban Steam Railways. H. E. O'Brien. Abstract from Pro. of Liverpool Engng. Soc. Discusses the value of electrification, summing up against electric traction on main lines. 2000 w. Elect'n, Lond—Jan. 22, 1909. No. 2208 A.

Locomotive Boilers.

Locomotive Boiler Inspection. Information from the second annual report of the New York Public Service Commission concerning work done. 3000 w. Boiler Maker—Feb., 1909. No. 2320.

Locomotive Design.

Weight Distribution of Mallet Articulated Locomotives. H. M. Sloat. Explains method of calculating the weight distribution. 1000 w. Am Engr & R·R Jour—Feb., 1909. No. 2238 C.

Locomotive Fuels.

The Purchase of Railway Fuel Coal. Eugene McAuliffe. A short paper introducing a discussion of this subject. 13500 w. Pro W Ry Club—Jan. 19, 1909. No. 2714 C.

Tests of Briquetted Fuel on Locomotives. Reports the tests made by the U. S. Geol. Survey. Ills. 3000 w. Ry. & Engng Rev—Jan. 30, 1909. No. 2183.

Tests of Lloydell Coal and Briquets on the Locomotive Testing Plant at Altoona. Abridged report of results, prepared by E. D. Nelson. 2800 w. R R Age Gaz—Feb. 5, 1909. No. 2300.

Locomotive Pressures.

High Steam Pressures in Locomotive Service. W. F. M. Goss. A review of a report to the Carnegie Institution of Washington. Describes the research and the means employed. 10500 w. Univ of Ill, Bul 26—Sept. 1, 1908. No. 2417 N.

Locomotives.

Horatio Allen and the Novelty Works. Edward P. Buffet. Sketch of the career of the man who brought the first locomotive to America. 3500 w. Power—Feb. 2, 1909. No. 2191.

Compound Atlantic Type Locomotives. C. M. & St. P. Ry. Illustrated detailed description of four cylinder engines, with data regarding their work. 1200 w. Ry & Engng Rev—Feb. 13, 1909. No. 2454.

Balanced Compound Passenger Locomotive. Illustrated description of en-

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gines for the N., C. & St. L Ry. 800 w. Am Engr & R R Jour—Feb., 1909. No. 2239 C.

Articulated Compound Locomotive 0-6-6-0 Type. Illustrated description of a Mallet engine recently delivered to the D., N. W., & P. Ry. 600 w. Am Engr & R R Jour—Feb., 1909. No. 2240 C.

2-8-0 for the Lehigh and Hudson River. Illustrated description of consolidation type locomotives for use in heavy freight and coal traffic. 700 w. Ry & Loc Engng —Feb., 1909. No. 2265 C.

New Locomotive Equipment; East Indian Railway. Brief illustrated description of two types of heavy passenger locomotives. 500 w. R R Age Gaz—Feb. 19, 1909. No. 2547.

Compound Articulated Locomotive: Eastern Railway of France. Illustration, with description of large American built engines on the Mallet principle. 1500 w. Mech. Engr—Jan. 29, 1909. No. 2351 A.

A Compound for the Western of France (Locomotive-Tender compound des Chemins de Fer de l'Ouest). Description of a recent four-cylinder, six-wheel model. Ills. 3000 w. Tech Mod—Jan., 1909. No. 2635 D.

New Test Locomotives for the Swiss Railways (Neue Versuchslokomotiven der Schweizerischen Bundesbahnen). M. Weiss. Illustrated description of superheater locomotives of series A 3-5 and C 4-5. 2000 w. Schweiz Bau—Jan. 23, 1909. No. 2691 B.

Locomotive Smoke.

The Smoke Nuisance in Cities. A. W. Gibbs. Shows the nature of the problem and the difficulties met in dealing with it, and reviews progress made in overcoming smoke from locomotives. 3500 w. R R Age Gaz—Feb. 26, 1909. No. 2777.

Locomotive Speed Recorders.

The Hasler Speed Recorder and Indicator. Illustrated description of a speed indicator and recorder for locomotives adopted on several continental railways. 1400 w. Engng—Feb. 5, 1909. No. 2487 A.

Train Lighting.

See D. C. Dynamos, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

NEW PROJECTS.

C. M. & St. P.

The Extension of the Chicago, Milwaukee & St. Paul Railway to the Pacific Coast. An illustrated account of this new line. 1200 w. Sci Am—Feb. 20, 1909. No. 2528.

England.

The Wilmslow and Levenshulme Railway. A new line in England, constructed by the London & North-Western Ry. Co., to open a new residence district and to relieve Stockport yard. Ills. 1200 w. Engr, Lond—Jan. 29, 1909. No. 2369 A.

PERMANENT WAY AND BUILDINGS.

Crossings.

The Railway Crossing. F. L. Somerville. Discusses the development and proposed elimination of grade crossings. 5000 w. Can Engr—Feb. 12, 1909. No. 2437.

Rail Joints.

Asymmetrical Rail Joints (Note sur le Joint asymétrique). H. Bouchard. Describes the theory, construction and results. Ills. 3800 w. Rev Gen de Chemins de Fer—Jan., 1909. No. 2626 G.

Rails.

The Hammer Blow from Incorrect Counterbalance. H. H. Vaughan. Gives report of a study made of a serious case of damaged rails on the Canadian Pacific Ry. 1800 w. Am Engr & R R Jour —Feb., 1909. No. 2237 C.

Reconstruction.

Rebuilding the Cairo Division of the Big Four. An illustrated account of the methods used, of the terminal facilities, operation, etc. 2000 w. R R Age Gaz—Feb. 26, 1909. No. 2776.

Roundhouses.

Engine Terminal Facilities Constructed by the Wabash Railroad Company at Decatur, Ill. A. O. Cunningham. Illustrated detailed description of recent improvements. 4000 w. Jour Assn of Engng Socs—Dec., 1908. No. 2414 C.

Terminals.

An English Passenger Terminal Station with Novel Track Arrangement. Plan and description of the Victoria Station (London) of the London, Brighton and South Coast Ry. 2000 w. Eng News—Feb. 11, 1909. No. 2395.

Ties.

Iron Sleepers and Wooden Sleepers. Editorial in *Zeit. des Ver. Deutsch Eisenbahn.* Discusses their relative economy. 5500 w. Bul. Int Ry Cong—Jan., 1909. No. 2436 G.

Tunnels.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Turning Y's.

The Employment of Turning Y's for Locomotives (L'Emploi de Circuits à Rebroussements pour le Tournage des Locomotives). M. Goupil. Describes various track arrangements for locomotives too long to be handled on turntables. Ills. 2000 w. Ann d Ponts et Chauss—1908-V. No. 2611 E + F.

TRAFFIC.

Commodity Clause.

Testing the Constitutionality of the

Commodity Clause. Reviews the brief in behalf of the railways, and the arguments of the counsel for the government. 3500 w. R R Age Gaz—Feb. 12, 1909. No. 2473.

Demurrage.

Reciprocal Demurrage. Arthur Hale. Address before the R. R. committees of the Nebraska Legislature. 1200 w. R R Age Gaz—Feb. 12, 1909. No. 2471.

MISCELLANY.

Africa.

The Railways of French North Africa. Edgar Allen Forbes. An illustrated article describing the lines, rolling stock, and management. 3000 w. Engineering Magazine—March, 1909. No. 2785 B.

England.

The Camerton and Limpley Stoke Railway. Illustrated description of a branch line of the Great Western Ry. Co., built mainly on the bed of the old Somersetshire Coal Canal. 1200 w. Engr, Lond—Feb. 5, 1909. No. 2490 A.

Government Control.

The Railways and the People. Frank Trumbull. From an address before the Board of Trade of Fort Worth, Texas. Discusses regulation of rates, overcapitalization, etc. 2000 w. R R Age Gaz—Feb. 19, 1909. No. 2546.

Management.

Methods of the Santa Fe. Efficiency in the Manufacture of Transportation. Charles Buxton Going. The first of a series of articles designed to give a broad view of the Santa Fe problem affecting the manufacture of transportation, and of the policy underlying the work. Ills. 4000 w. Engineering Magazine—March, 1909. Serial, 1st part. No. 2782 B.

See also Education, under INDUSTRIAL ECONOMY.

Norway.

The Bergen-Christiania Railway. Map and brief account of interesting railway construction. 800 w. Engng—Feb. 12, 1909. No. 2591 A.

Southern Pacific.

Twenty-fourth Annual Report of the Southern Pacific Company and Proprietary Companies for the fiscal year ended June 30, 1908. Report, with editorial review. 8500 w. R R Age Gaz—Feb. 12, 1909. No. 2470.

United States.

Railroads in the Upbuilding of the South. W. J. Meany. A general review of what has been accomplished, especially recent important roads, and the future needs. 5000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1560 C.

Problems Fronting Railroads in South Atlantic States. J. T. Odell. Discusses the railroad situation in the South, the need for improvement and modernization. 2200 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1559 C.

STREET AND ELECTRIC RAILWAYS

Adhesion System.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Brakes.

Improvement in the Upkeep of the Braking Equipment of Tramcars. P. Scholtes. Translation of a report of the replies received to questions sent out. 2500 w. Elect'n, Lond—Feb. 5, 1909. No. 2477 A.

Braking.

The Overloading of Tramway Cars (I Sovraccarichi delle Vetture tramviarie Considerati nei Riguardi della Sicurezza dell' Esercizio). Guido Vallecchi. A consideration of safety in operating electric cars with particular reference to brakes. Ills. 5000 w. Ing Ferro—Jan. 1, 1909. No. 2654 D.

Canal Haulage.

Electrical Haulage of Canal Boats (La Traction électrique des Bateaux sur les Canaux). P. du Bousquet. A discussion of its advantages and disadvantages, reviewing experiences and tests on various European canals. Ills. 11200 w. Mem Soc Ing Civ de France—Nov., 1908. No. 2605 G.

Car Fenders.

Car Fender and Wheelguard Tests. Recommendations and report of experience with various types in the tests recently made by the N. Y. Public Service Commission. 4000 w. Eng News—Feb. 25, 1907. No. 2759.

Fender and Wheelguard Tests of the Public Service Commission of New York, First District. Abstract of the report of tests made for the Commission. 4000 w. Elec Ry Jour—Feb. 6, 1909. No. 2288.

Street Car Fenders and Wheel Guards. An account of the tests by the Public Service Commission. Ills. 2500 w. Munic Jour & Engr—Feb. 10, 1909. No. 2383.

Car Inspection.

The Reduction of Equipment Failures and Maintenance Cost on the Third Ave-

nue Railroad System, New York. Gives results of improvement due mainly to weekly inspection. 1500 w. Elec Ry Jour —Feb. 20, 1909. No. 2534.

Electric Traction.

Power Requirements of a Street Railway (Bestimmung des Kraftbedarfs für Strassenbahnen). Fritz Block. Mathematical explanation of the method of calculation. Ills. Serial. 1st Part. 1500 w. Elektrotech Rundschau—Jan. 2, 1909. No. 2824 D.

Interurban.

Interurban Railway Developments in the United States. George Ethelbert Walsh. A discussion of the competition between steam and electric railways. 3500 w. Cassier's Mag—Feb., 1909. No. 2327 B.

Japan.

Municipal Electric Road of Osaka, Yoshio Katagiri. Brief illustrated description of the only municipally-owned street railway in Japan. 400 w. Munic Jour & Engr—Feb. 3, 1909. No. 2236.

Locomotives.

See Simplon, under STREET AND ELECTRIC RAILWAY.

London.

Putney to Hammersmith Tramway. Illustrated description of the first trolley line over a London bridge. 2500 w. Tram & Ry Wld—Feb. 4, 1909. No. 2531 B.

Management.

The Development of a Small Road. An illustrated account of the system at Sheboygan, Wis. 3500 w. Elec Ry Jour—Feb. 13, 1909. No. 2444.

Street Railways vs. People. Samuel H. Barker. From an address before Wharton Sch. of Fin. & Com., Univ. of Penn. Discusses street railway capitalization and management in large cities, cost of service, etc. 4000 w. Eng News—Feb. 25, 1909. No. 2756.

Power Stations.

See Central Stations, and Hydro-electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Records.

See Record Systems, under CIVIL ENGINEERING, CONSTRUCTION.

Signalling.

Automatic Electric Railway Signals. William K. Waldron. Explains the principles involved, and gives illustrated description of the "Solenoid" type, operated on third-rail, direct-current track circuits. 1500 w. Elec Wld—Feb. 11, 1909. No. 2391.

Simplon.

New Features of the Simplon Line. C. L. Durand. Describes new points relating to the tunnel section and the new Brown-Boveri electric locomotives used. Ills. 3000 w. Elec Rev, N Y—Feb. 20, 1909. No. 2554.

Single-Phase.

Electric Traction by Simple Alternating Current in Europe. H. Merchand-Thiriar. Gives a description of the Locarno-Pontebrolla-Bignasco line on the monophase system. Ills. 2400 w. Bul Int Ry Cong —Jan, 1909. No. 2434 G.

The Electrification on the London, Brighton, and South Coast Railway. Editorial discussion of this overhead single-phase system. 2500 w. Engng—Feb. 5, 1909. No. 2488 A.

Subways.

The New York Rapid Transit Subway. William Barclay Parsons. Illustrated detailed description of the design, construction, conditions, etc. Discussion. 50000 w. Inst of Civ Engrs—No. 3739. No. 2795 N.

The Return on the Investment in the New York Subways. Abstract of the seventh report giving an analysis of earnings and expenses. 3500 w. Elec Ry Jour—Feb. 27, 1909. No. 2779.

See also Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Switzerland.

The Montreux-Bernese Oberland Electric Railroad. B. F. Hirschauer. Illustrated description of a new line through a picturesque mountain region in Switzerland. 2500 w. Elec Rev, N Y—Feb. 6, 1909. No. 2321.

The Monthey-Champéry Railway (Die Monthey-Champéry-Bahn). Illustrated description of a line in Switzerland having stretches on the combined rack and adhesion system. Serial. 1st part. 2000 w. Schweiz Bau—Jan. 2, 1909. No. 2689 B.

The Bellinzona-Mesocco Railway (Die elektrische Bahn Bellinzona-Mesocco). J. G. Boesch. Illustrated detailed description. Serial. 1st part. 1500 w. Elek Kraft u Bahnen—Jan. 4, 1909. No. 2823 D.

Train Acceleration.

The Industrial Definition and Measurement of Train Acceleration. Abstract translation of a paper by C. O. Mailloux, read at the recent Int. Elec. Cong. at Marseilles. Explains a method that has proved its practical utility. 3000 w. Elec Ry Jour—Feb, 13, 1909. No. 2445.

Trolley Wires.

The Need for Testing Trolley Wire. Carl F. Woods. Parts of a paper read before the Am. Chem. Soc. showing what tests should be performed on copper trolley wire for the best service. 3000 w. Eng News—Feb. 18, 1909. No. 2526.

Wheel Guards.

See Car Fenders, under STREET AND ELECTRIC RAILWAYS.

We supply copies of these articles. See page 159.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Der Motorwagen. *s-m.* Berlin.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

GEORGE WALLACE MELVILLE

REAR ADMIRAL U. S. NAVY, RETIRED

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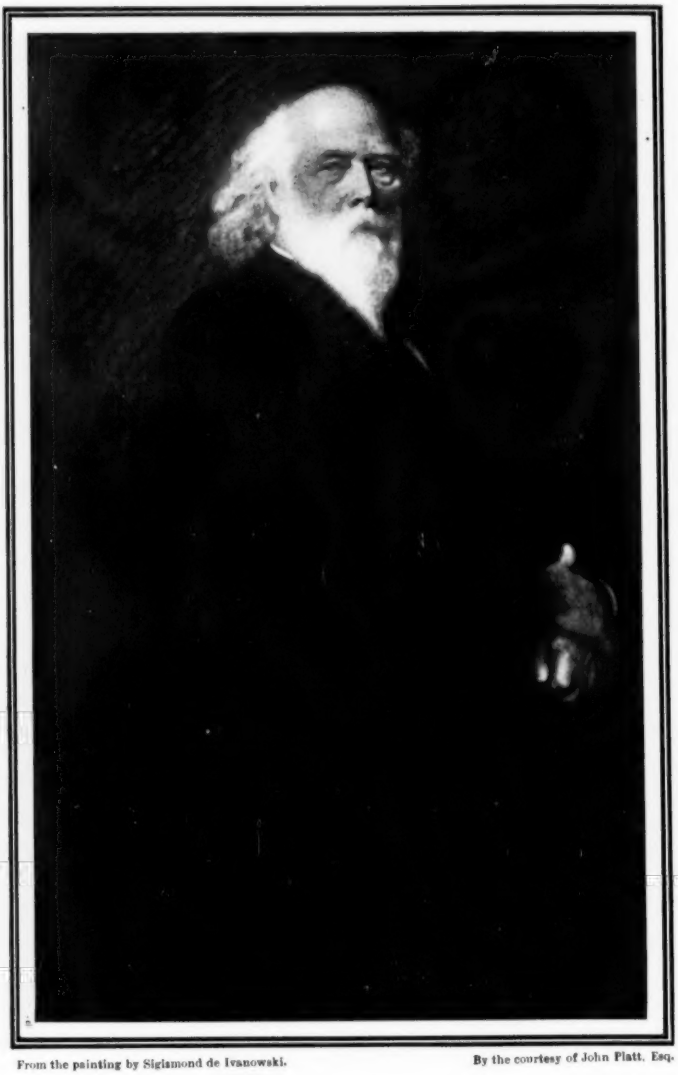
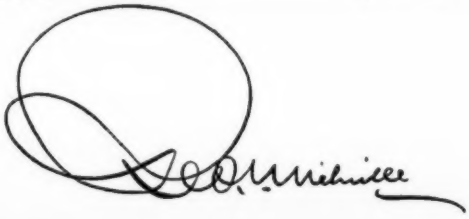
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